ENSTROM 480

OPERATOR'S MANUAL

AND

FAA APPROVED

ROTORCRAFT FLIGHT MANUAL

* * * * *

REPORT NO. 28-AC-022

TYPE CERTIFICATE NO. H1CE

HELICOPTER SERIAL NO. ____________

HELICOPTER REGISTRATION NO. ____________

* * * * *

THIS MANUAL MUST BE CARRIED IN THE HELICOPTER AT ALL TIMES. CHAPTERS 1, 2, 3, 4, AND 5 ARE FAA APPROVED.

FAA APPROVED BY: for ______________________________
DONALD P. MICHAL, MANAGER
CHICAGO AIRCRAFT CERTIFICATION OFFICE
CENTRAL REGION
FEDERAL AVIATION ADMINISTRATION

DATE: June 7, 1993

ENSTROM 480
OPERATOR'S MANUAL
TABLE OF CONTENTS

ENSTROM 480 OPERATOR'S MANUAL
LOG OF REVISIONS

REV. NO.	PAGES	DESCRIPTION	DATE	FAA APPROVAL
1	Various Pages noted by black line along right side of columns	Added landing gear fairings, changed pitot tube locations, other minor modifications.	11/10/93	Joseph C. Miess
2	i,ii,iii,iv,v,vi, 1-1,5-10,5-12,6-1,6-3 - 6-4B,6-9 - 6-13,8-1-1 thru 8-4-2	Revised table of contents, minor text changes, added supplements 1,2,3,and 4	06/01/94	Joseph C. Miess
3	Entire manual	Numerous minor changes effecting text that resulted in repaginating the entire manual. Added report number as 28-AC-022. Added lateral c.g. limits.	10/07/94	Joseph C. Miess
4	Entire manual	Reformatted manual to match AC27.1 format, made numerous minor changes and corrections, re-drew various figures to improve clarity.	2/1/95	Joseph C. Miess
5	1-i,1-1,1-5,1-6, 1-8,1-9,1-11,1-15,2-i,2-6 thru 2-15,3-i,3-5 thru 3-14,3-16,3-17, 4-i,4-1,4-3,4-5, 4-6,4-7,4-12,4-14 thru 4-18,4-20,4-21,4-22,4-23,4-26,4-27,4-29 thru 4-32,5-0,5-1-i,5-2-1,5-2-3,6-i thru 6-17,7-ii,7-7,7-8,7-33,7-34,7-36,8-i,8-2,8-5,8-7,8-8,9-i,9-1,9-4	Revised environmental temperature limits. Expanded coverage of N_2/N_R Tachometer batt/Main Bus Switch. Added LTE discussion. Expanded fuel and oil type requirements. Numerous other minor changes and corrections.	6/12/95	Mark W. Anderson

ENSTROM 480 OPERATOR'S MANUAL
LOG OF REVISIONS

REV. NO.	PAGES	DESCRIPTION	DATE	FAA APPROVAL
6	INTRO-1,INTRO-2,1-2,1-9,1-11,1-12,2-i,2-ii,2-2,2-4,2-5 thru 2-17,3-2,3-3,3-7,3-8,3-16,3-17,4-2,4-15,4-18,4-26,4-32,5-0,5-1-1,5-5-i,5-5-1 thru 5-5-6,5-6-i,5-6-1 thru 5-6-22,6-i,6-1,6-4,6-9,6-10,6-17 thru 19,7-9 thru 7-17,7-32,7-33,8-2,8-5,8-7,4-i	Correct numerous minor typographical errors. Add Supplement for camera door. Increased rotor rpm and torque limits.	8/12/96	Joseph C. Miess
7	iii-1,iv thru vii,5-0,5-4-6,5-6-i,5-6-2,5-6-3,5-6-15,5-6-16,5-6-18 thru 5-6-22,5-7-i thru 5-7-8,7-17	Add supplement for air conditioning, minor typographical corrections	11/27/96	Joseph C. Miess
8	i,iv-1,v,vi,vii,5-0,5-8-i thru 5-8-6	Add supplement for Emergency Floats	1/27/97	Joseph C. Miess
9	iv-1,v-vii,2-i,2-2 thru 2-12,5-1-2,5-2-3,5-3-3,5-4-3,5-6-3 thru 5-6-4,5-6-19,5-8-i thru 5-8-8, 6-17 thru 6-20,5-6-17,7-26	Re-worded exterior (Preflight) check, added vibration information for float operations, corrected minor typographical errors	1/19/98	Joseph C. Miess
10	Manual cover, i-vii,2-1,2-3,2-4,2-6 thru 2-12,3-i,3-6 thru 3-9,4-26,5-1-2,5-7-4,5-8-i,5-8-3 thru 5-8-8,7-9,7-27,7-34,7-35,8-5,8-8	Added and corrected page effectivity, added vibration absorber to preflight inspection, replaced Rate of Climb chart in Section 4 for clarity, added cylinder pressure chart to Supplement 6, numerous other minor changes	5/27/99	Joseph C. Miess

APPROVED FOR THE MANAGER, CHICAGO AIRCRAFT CERTIFICATION OFFICE
CENTRAL REGION FEDERAL AVIATION ADMINISTRATION

ENSTROM 480 OPERATOR'S MANUAL
LOG OF REVISIONS

REV. NO.	PAGES	DESCRIPTION	DATE	FAA APPROVAL
11	Manual cover,ii thru vii,INTRO-1, 1-2 thru 1-8, 2-2,2-4,2-7,3-i,3-19,5-6-3 thru 5-6-4,7-ii,7-5 thru 7-7.1,7-9,7-10.1,7-12 thru 7-14,7-16,7-17,7-27,8-1,8-5,8-7 thru 8-9	Corrected error on Manual Cover, Added color illustrations of instrument markings, Redrew Figure 1-2 for clarity, Added Cyclic Control Vibration Absorbers to Preflight Check and Emergency Procedures, Updated Oil Specifications, Added illustrations of optional instrument panel and pedestal, Added illustration of slide controls, Added to and corrected systems description information.	12/17/99	Joseph C. Miess
12	i,iv thru viii,2-i,2-4 thru 2-7.1, 3-i,3-10 thru 3-12,6-2,6-8,6-9,6-20,7-i,7-ii,7-19,7-21 thru 7-24,7-33 thru 7-35,8-i,8-5.1,8-5.2,8-6 thru 8-7.1	Added preflight check, system description, and servicing instructions for oil lubricated main rotor flapping bearings; Added preflight check, system description, and emergency procedure for main rotor transmission filtration/cooling system; Corrected errors on Figure 6-1; Redrew Figures 6-5,6-6, and 6-8; Added metric equivalents to Table 8-1.	07/06/00	Joseph C. Miess
13	iv,vi,vii,viii,1-9,3-5,4-ii,4-13,4-14,4-28,4-29,5-6-15,5-7-i, 5-7-1 thru 5-7-10,7-9,8-5	Removed takeoff/landing gross weight limitations, revised H-V Diagram, revised air conditioning supplement (Supplement 7), changed references in text from Allison to Rolls-Royce	08/25/04	Joseph C. Miess
14	iv,vi,vii,viii,2-2,2-5,7-i,7-ii,7-16,7-17,7-18,7-21 thru 7-24,8-i,8-5.1 thru 8-5.3,8-6,8-7,9-i,9-4	Incorporated information for oil lubricated flapping bearings, oil lubricated lower pulley bearings, and elastomeric main rotor dampers.	03/01/05	Joseph C. Miess
15	i,vi thru x,2-2, 2-4,2-5,8-i,8-5.4,8-5.5,8-6	Added EASA Revision and Supplement approval pages. Added information about oleo condition placards installed in accordance with Service Directive Bulletin T-021.	08/30/05	Joseph C. Miess

ENSTROM 480 OPERATOR'S MANUAL
LOG OF REVISIONS

REV. NO.	PAGES	DESCRIPTION	DATE	FAA APPROVAL
16	i,v thru xi,2-2, 2-4,2-5,8-i,8-3, 8-6 thru 8-16	Added information about inspecting/servicing the overrunning clutch (ORC) when the ORC cover is equipped with a sight plug	09/17/06	Joseph C. Miess
17	v, vi, ix, x, xi, 1-2, 5-6-3, 5-6-3.1	Added Speed Avoid Range to Dual Tachometers	03/06/07	Joseph C. Miess
18	v, ix-xi, 1-8, 1-12, 8-2, 8-13 through 8-16	Clarified temperature limits for use of anti-icing fuel additives. Removed biocidal additive requirement. Updated fuels, lubricants, specifications.	09/20/10	Joseph C. Miess
19	v, vi, viii through xi, 1-8, 1-12, 1-17, 2-i through 2-2, 2-4 through 2-7.2, 2-11, 2-12, 2-18, 3-i, 3-ii, 3-8, 3-9, 3-12, 3-16, 3-18, 3-19, 6-i, 6-2, 6-10, 6-11, 7-16, 7-22 through 7-22.1, 7-28, 7-30, 7-35, 8-i, 8-2, 8-3, 8-5 through 8-8, 8-13 through 8-16, 9-i, 9-3.	General text clarifications and revisions throughout Chapters 2, 3, 7, 8 and 9. Para. 2-9.1, 2-11, 2-17: revised (fuel management, dipstick removed); Para. 2-11, 7-44, Figure 8-1, Para. 8-9, Figure 8-2, Table 8-1: revised (vented clutch oil reservoir). Para. 2-37: revised; Para. 2-49: new (deceleration check). Para. 3-40: revised (lamiflex bearing failure). Para. 6-8: revised (battery weight and balance). Figure 6-1: revised; Para. 6-9: new (operation without doors).	08/17/15	Ronald D. McElroy
20	v, ix, 1-2, 3-ii, 3-19	Updated Dual Tachometer Speed Avoid Range (p. 1-2), Added Cyclic Trim Failure Emergency Procedure (p. 3-19).	05/19/16	Ronald D. McElroy
21	v, vi, viii, ix, x, xi 5-6-3, 5-6-3.1, 5-6-5, 6-2, 7-13, 7-35, 8-15, 9-i, 9-3, 9-4	Updated Dual Tachometer Speed Avoid Range (p. 5-6-3, 5-6-3.1); Updated Max. Allowable Torque Chart (p. 5-6-5); Corrected typo (p. 6-2); Clarified caution light illumination parameters (p. 7-13, 7-35) Updated recommended oil list (p. 8-15); Updated Vortex Ring State (Settling With Power) (p. 9-3, 9-4).	10/09/19	RYAN BRUCE NELSON Digitally signed by RYAN BRUCE NELSON Date: 2019.11.14 15:05:44 -06'00' Ryan Nelson

ENSTROM 480 OPERATOR'S MANUAL
LOG OF REVISIONS

REV. NO.	DATE	EASA APPROVAL	FAA APPROVAL ON BEHALF OF EASA
1	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
2	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
3	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
4	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
5	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
6	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
7	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
8	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
9	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
10	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
11	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
12	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
13	May 30/05 Jun 6/05	2005-4682 2005-5376	N/A N/A
14	May 29/05	2005-4678	N/A
15	Sep 9/05	Decision 2004/04/CF	N/A
16	Sep 17/06	Decision 2004/04/CF	N/A
17	Aug 2/07	EASA.IM.R.C.01427	N/A
18	Jan 27/14	EASA 10045751	N/A
19	May 1/17	FAA/EASA T.I.P. *	M. Javed
20	May 1/17	FAA/EASA T.I.P. *	M. Javed
21	Nov 14/19	FAA/EASA T.I.P. **	R. Nelson

* Section 3.2 T.I.P. Revision 5

** Section 3.5.12 T.I.P. Revision 6

ENSTROM 480 OPERATOR'S MANUAL
LOG OF SUPPLEMENTS

SUPPLEMENT NO.	PAGES	DESCRIPTION	DATE	FAA APPROVAL
1	5-1-1 thru 5-1-6	Cargo Hook	6/1/94	Joseph C. Miess
2	5-2-1 thru 5-2-6	Snow Shoes	6/1/94	Joseph C. Miess
3	5-3-1 thru 5-3-6	External Fuel Filter	6/1/94	Joseph C. Miess
4	5-4-1 thru 5-4-6	Baggage Box Extension	6/1/94	Joseph C. Miess
5	5-5-i thru 5-5-6	Camera Door	8/12/96	Joseph C. Miess
6	5-6-i thru 5-6-22	Increased Rotor Speed & Torque Limits	8/12/96	Joseph C. Miess
7	5-7-i thru 5-7-8	Air Conditioning	11/27/96	Joseph C. Miess
8	5-8-i thru 5-8-8	Pop-out Floats	01/23/98	Joseph C. Miess

ENSTROM 480 OPERATOR'S MANUAL
EASA LOG OF SUPPLEMENTS

SUPPLEMENT NO.	DATE	EASA APPROVAL	FAA APPROVAL ON BEHALF OF EASA
1	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
2	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
3	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
4	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
5	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
6	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
7	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A
8	Sep 28/03	Article 3, Commission Regulation (EU) 748/2012	N/A

ENSTROM 480
OPERATOR'S MANUAL
TABLE OF PAGE EFFECTIVITY

PAGE	REVISION
Manual Cover	11
i	16
ii	11
iii	11
iv	15
v	21
vi	21
vii	16
viii	21
ix	21
x	21
xi	19
INTRO-i	6
INTRO-1	11
INTRO-2	6
1-i	5
1-1	5
1-2	20
1-3	11
1-4	11
1-5	11
1-6	11
1-7	11
1-8	19
1-9	13
1-10	4
1-11	6
1-12	19
1-13	4
1-14	4
1-15	5
1-16	4
1-17	19
2-i	19
2-ii	19
2-1	19
2-2	19
2-3	10
2-4	19
2-5	19
2-6	19
2-7	19
2-7.1	19
2-7.2	19
2-8	10
2-9	10
2-10	10
2-11	19
2-12	19
2-13	6
2-14	6
2-15	6
2-16	6
2-17	6
2-18	19
3-i	19
3-ii	20
3-1	4
3-2	6
3-3	6
3-4	4
3-5	13
3-6	10
3-7	10
3-8	19
3-9	19
3-10	12
3-11	12
3-12	19
3-13	5
3-14	5
3-15	4
3-16	19
3-17	6
3-18	19
3-19	20
4-i	6
4-ii	13
4-1	4
4-2	6
4-3	5
4-4	4
4-5	5
4-6	5
4-7	5
4-8	4
4-9	4
4-10	4
4-11	4
4-12	5
4-13	13
4-14	13
4-15	6
4-16	5
4-17	5
4-18	6
4-19	4
4-20	5
4-21	5
4-22	5
4-23	5
4-24	4
4-25	4
4-26	10
4-27	5
4-28	13
4-29	13
4-30	5
4-31	5
4-32	6
4-33	4
5-0	8
5-1-i	5
5-1-1	6
5-1-2	10
5-1-3	4

ENSTROM 480
OPERATOR'S MANUAL
TABLE OF PAGE EFFECTIVITY

PAGE	REVISION
5-1-4	4
5-1-5	4
5-1-6	4
5-2-i	4
5-2-1	5
5-2-2	4
5-2-3	9
5-2-4	4
5-2-5	4
5-2-6	4
5-3-i	4
5-3-1	4
5-3-2	4
5-3-3	9
5-3-4	4
5-3-5	4
5-3-6	4
5-4-i	4
5-4-1	4
5-4-2	4
5-4-3	9
5-4-4	4
5-4-5	4
5-4-6	7
5-5-i	6
5-5-1	6
5-5-2	6
5-5-3	6
5-5-4	6
5-5-5	6
5-5-6	6
5-6-i	7
5-6-1	6
5-6-2	7
5-6-3	21
5-6-3.1	21
5-6-4	11
5-6-5	21
5-6-6	6
5-6-7	6
5-6-8	6
5-6-9	6
5-6-10	6
5-6-11	6
5-6-12	6
5-6-13	6
5-6-14	6
5-6-15	13
5-6-16	7
5-6-17	9
5-6-18	7
5-6-19	9
5-6-20	7
5-6-21	7
5-6-22	7
5-7-i	13
5-7-1	13
5-7-2	13
5-7-3	13
5-7-4	13
5-7-5	13
5-7-6	13
5-7-7	13
5-7-8	13
5-7-9	13
5-7-10	13
5-8-i	10
5-8-1	8
5-8-2	9
5-8-3	10
5-8-4	10
5-8-5	10
5-8-6	10
5-8-7	10
5-8-8	10
6-i	19
6-1	6
6-2	21
6-3	5
6-4	6
6-5	5
6-6	5
6-7	5
6-8	12
6-9	12
6-10	19
6-11	19
6-12	5
6-13	5
6-14	5
6-15	5
6-16	5
6-17	9
6-18	9
6-19	9
6-20	12
7-i	14
7-ii	14
7-1	4
7-2	4
7-3	3
7-4	3
7-5	11
7-6	11
7-6.1	11
7-7	11
7-7.1	11
7-8	5
7-9	13
7-10	6
7-10.1	11
7-11	6
7-12	11
7-13	21
7-14	11

ENSTROM 480
OPERATOR'S MANUAL
TABLE OF PAGE EFFECTIVITY

TABLE OF CONTENTS

INTRODUCTION

INTRO-1 General This manual contains the operating instructions, procedures and limitations for the Enstrom 480 helicopter. The manual is divided into two basic parts, the FAA approved Rotorcraft Flight Manual (RFM) and Supplemental Data Provided by Enstrom Helicopter Corporation. Sections 1, 2, 3, 4, and 5 make up the FAA approved RFM. It is required by Federal Regulations that this manual be carried in the helicopter at all times.

INTRO-2 Warnings, Cautions, and Notes Warnings, Cautions, and Notes emphasize important and critical instructions and are used for the following conditions.

WARNING

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

CAUTION

An operating procedure, practice, etc. which, if not strictly observed, could result in damage to or destruction of equipment.

NOTE

An operating procedure, practice, etc., which is essential and requires additional information.

INTRO-3 Description This manual contains the best operating instructions and procedures for the 480 helicopter under most circumstances. The observance of limitations, performance and weight and balance data provided is mandatory. The observance of procedures is mandatory except when modification is required because of multiple emergencies, adverse weather, terrain, etc. Your flying experience is recognized, and therefore, basic flight principles are not included. **THIS MANUAL SHALL BE CARRIED IN THE HELICOPTER AT ALL TIMES.**

INTRO-4 Table of Contents The table of contents lists every titled paragraph, figure, and table contained in this manual.

INTRO-5 Reporting of Errors Every effort is made to keep this publication current and error free. However, we cannot correct an error unless we know of its existence. You are encouraged to report errors, omissions, and recommendations for improving this publication by contacting Enstrom Helicopter.

INTRO-6 Explanation of Change Symbols Except as noted below, changes to the text and tables, including new material on added pages, are indicated by a vertical line in the margin. The vertical line will extend close to the entire area of the material affected. Symbols show current changes only. Change symbols are not utilized to indicate changes in the following:

a. Indexes, figures, and tabular data where the change cannot be readily identified.

b. Blank space resulting from the deletion of text, illustration, or a table.

c. Correction of minor errors, such as spelling, punctuation, relocation of material, etc. unless such correction changes the meaning of the material.

INTRO-7 Use of Word Shall, Should, and May Within this technical manual, the word "shall" is used to indicate a mandatory requirement. The word "should" is used to indicate a nonmandatory but preferred method of accomplishment. The word "may" is used to indicate an acceptable method of accomplishment.

INTRO-8 Definitions of Abbreviations

The following list provides definitions for abbreviations used in this manual. The same abbreviation applies for either singular or plural applications.

LIST OF ABBREVIATIONS

Abbreviation	Definition
ABS	Absolute
AGL	Above Ground Level
ALT	Altitude
C	Celsius
CAS	Calibrated Airspeed
CG	Center of Gravity
CL	Centerline
CONF	Configuration
CONT	Continuous
END	Endurance
F	Fahrenheit
FLT	Flight
FPM	Feet per Minute
FT	Foot
FT/MIN	Feet per minute
FWD	Forward
GAL	Gallon
GAL/HR	Gallon per hour
GW	Gross Weight
HR	Hour
IAS	Indicated Airspeed
IGE	In ground effect
IN	Inch
IN HG	Inches of mercury
ISA	International Standard Atmosphere
KIAS	Knots indicated airspeed
KT	Knot
LB	pound
LB/HR	pounds per hour
MAX	Maximum
MB	Millibars
MIN	Minimum
MIN	Minute
N1	Gas producer turbine speed
N2	Power turbine speed
NO.	Number
NM	Nautical mile
OAT	Outside Air Temp.
OGE	Out of ground effect
PRESS	Pressure
PSI	Pounds per square inch
R/C	Rate of climb
R/D	Rate of descent
RPM	Revolutions per minute
SHP	Shaft horsepower
SPEC	Specification
STA	Station
SQ FT	Square feet
TAS	True airspeed
TOT	Turbine outlet temp
TRQ	Torque
Vd	Maximum design dive airspeed
VDC	Volts direct current
Vh	Maximum level flight airspeed at maximum continuous power
Vne	Velocity never exceed (airspeed limitation)
Vy	Best rate of climb airspeed
WT	Weight
XMSN	Transmission

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

OPERATING LIMITATIONS

SECTION I. INTRODUCTION

1-1. Purpose This chapter includes operating limitations and restrictions that must be observed during ground and flight operations.

1-2. General The operating limitations set forth in this chapter are the direct results of design analysis and flight tests. Compliance with these limits will allow the pilot to derive maximum utility from the helicopter.

1-3. Operational Limits Anytime an operational limit is exceeded an appropriate entry shall be made in the aircraft log book. The entry shall state what limit or limits were exceeded, and the range and time beyond the limits including any additional data that would aid maintenance personnel in the proper disposition of the entry and inspection of the aircraft.

SECTION II. GENERAL

1-4. Kinds of Operation

a. This aircraft is certified in normal category for day and night VFR operation in non-icing conditions when the appropriate instruments and equipment required by the airworthiness and/or operating rules are installed and approved and are in operable condition.

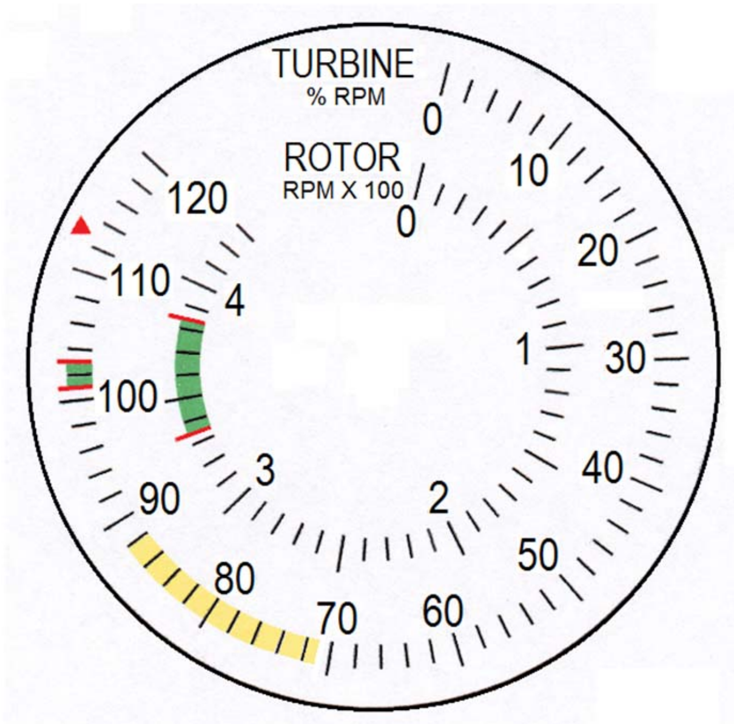
b. For night operations, the night curtain, P/N 4119836, must be installed between the console and cabin shell.

1-5. Minimum Crew Requirements The minimum crew is one pilot. Solo from left seat only.

SECTION III. HELICOPTER AND SYSTEM LIMITS

1-6. Instrument Markings The operating limitations for both the helicopter and systems are listed below and presented in figure 1-1.

a. Operating Limitations and Ranges. Operating limitations and ranges are illustrated by the colored markings which appear on the dial faces of engine, flight and utility system instruments. Red markings on the dial faces of these instruments indicate the maximum and/or minimum limits. The green markings on the instruments indicate the safe normal range of operation. The yellow markings on the instruments indicate the range when special attention should be given to the operation covered by the instrument. Operation is permissible in the yellow range, but should be avoided.

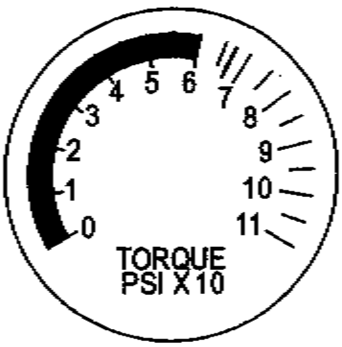


DUAL (ROTOR AND POWER TURBINE) TACHOMETER

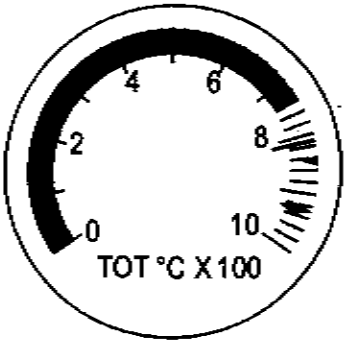
ROTOR		
385 RPM	Red Radial	Maximum Power OFF
334-385 RPM	Green Arc	Continuous Operation (Including Autorotation)
334 RPM	Red Radial	Minimum Power OFF

POWER TURBINE (N_2)		
113% RPM	Red Arrowhead	15 Second Maximum Transient N_2 Varies Linearly from 113% in Autorotation per Figure 1-2.
103% RPM	Red Radial	Maximum N_2 Continuous
101-103% RPM	Green Arc	Normal Operating Range
101% RPM	Red Radial	Minimum N_2 Continuous
71-88 % RPM	Yellow Arc	Speed avoid range. Move through range as expediently as possible.

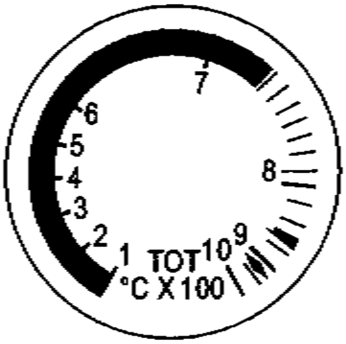
FIGURE 1-1. INSTRUMENT MARKINGS (Sheet 1 of 4)



TORQUEMETER		
67 PSI	Red Radial	Maximum for Takeoff
60-67 PSI	Yellow Arc	5 minute limit
0-60 PSI	Green Arc	Continuous Operation



"PASSIVE" INDICATOR



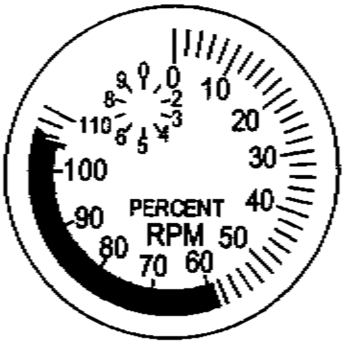
"ACTIVE" INDICATOR

TURBINE OUTLET TEMPERATURE		
927°C	Red Diamond	Maximum Temp. 1 Second - Starting Only
843°C	Red Arrowhead	Maximum Transient Limit (10 seconds on start)
810-843°C		Maximum 6 seconds during transient power only
810°C	Red Radial	Maximum starting and takeoff (5 minutes)
737-810°C	Yellow Arc	Maximum 5 minutes
0 - 737°C	Green Arc	Continuous operation

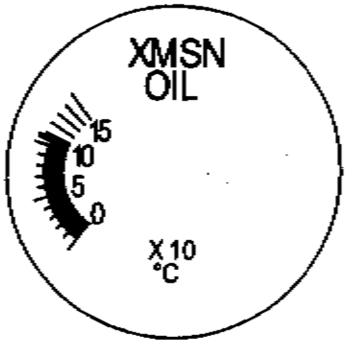
FIGURE 1-1. INSTRUMENT MARKINGS (Sheet 2 of 4)

NOTE

Some GAS PRODUCER TACHOMETERS have the "Normal Operation" range marked as 60% - 105%.

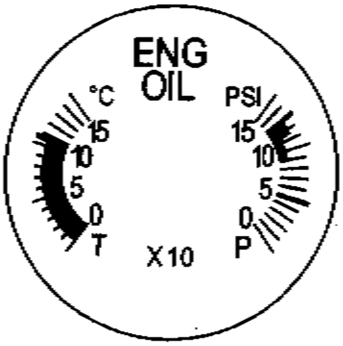


GAS PRODUCER TACHOMETER (N_1)		
106% RPM	Red Arrowhead	Maximum
105% - 106% RPM		Maximum for 15 seconds
105% RPM	Red Radial	Maximum Continuous
59% - 105% RPM	Green Arc	Normal Operation



MAIN TRANSMISSION OIL TEMPERATURE		
107°C	Red Radial	Maximum
0 - 107°C	Green Arc	Normal Operation

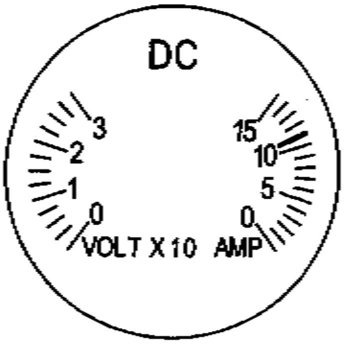
FIGURE 1-1. INSTRUMENT MARKINGS (Sheet 3 of 4)



ENGINE OIL TEMPERATURE AND PRESSURE

TEMPERATURE		
107°	Red Radial	Maximum Oil Temperature
0 - 107°C	Green Arc	Normal Operation

PRESSURE		
130 PSI	Red Radial	Maximum Oil Pressure
115 - 130 PSI	Green Arc	Normal Operation for All N_1 Speeds
90 - 115 PSI	Narrow Green Arc	Oil Pressure Range for N_1 Speeds Below 94.2%
50 - 90 PSI	Yellow Arc	Oil Pressure Range for N_1 speeds below 78.5%
50 PSI	Red Radial	Minimum Oil Pressure



VOLT/AMMETER

AMMETER		
110 Amps	Red Radial	Maximum Current

FIGURE 1-1. INSTRUMENT MARKINGS (Sheet 4 of 4)

1-7. Rotor Limitations

a. Normal Operating Limits. The maximum and minimum rotor RPM limits shown in Figure 1-1 apply during continuous powered flight and autorotation for all aircraft weight configurations.

b. Minimum Transient Rotor Speed. The minimum allowable transient rotor speed following engine failure or sudden power reduction for practice forced landing is 300 RPM. This is a transient limit and positive corrective action (lowering the collective) must be taken immediately by the pilot to regain at least 334 RPM (minimum power off rotor RPM).

1-8. Transmission Limits The main transmission is subject to the torque limitations shown in Figure 1-2. Operating time above the maximum continuous limit of 60 PSI in the range of 60 - 67 PSI is limited to 5 minutes duration.

WARNING

Aircraft operating limits are based on the transmission torque limits and not the engine torque limits.

1-9. Engine Limits

a. Power Limits

(1). Takeoff Power. Takeoff rated power is the maximum power permitted and is limited to a period of 5 minutes.

Takeoff power is defined by a combination of torque and N_2 power turbine speed but may be limited by Turbine Outlet Temperature (TOT) on hot days or at high altitude. The limits for takeoff for this helicopter are:

Torque . . . . 67 PSI

Turbine Outlet
Temperature . . . . 810 Degrees C

N_2 RPM 103%

(2). Normal Rated Power (Continuous). Normal rated power is the maximum continuous power limit for this helicopter and is also defined by a combination of torque and N_2 RPM but may, under circumstances of high altitude or hot ambient conditions, be limited by TOT. The normal rated (continuous) power limits for this helicopter are:

Torque . . . . 60 PSI

Turbine Outlet
Temperature . . . . 737 Degrees C

N_2 RPM 103%

b. Engine Overspeed. The engine overspeed limits are given below.

(1). Gas Producer (N_1) Turbine:
105% Continuous
106% for 15 seconds

(2). Power Turbine (N_2):
(See Figure 1-2)

c. Engine Starting.

(1). Start Cycle Time. The minimum time between ground starting attempts is 30 seconds.

(2). Minimum Oil Temperature. The minimum oil temperature for starting is -54 Degrees C for MIL-PRF-7808 series oil and -40 Degrees C for MIL-PRF-23699 series oil.

(4). Oil Pressure During Start. A positive indication of oil pressure must be obtained when 59% N_1 is reached and must stabilize at least at 50 PSIG at idle.

CAUTION

Following starts in very cold ambient conditions, the oil pressure may exceed 130 PSI immediately after start up to a maximum of 150 PSI. The engine must not be accelerated from idle until the oil pressure has returned within the specified limits.

d. Ambient Temperature and Altitude Limits. The ambient temperature limits for the engine are -54°C from sea level to 20,000 feet pressure altitude, and up to +46°C from sea level to 6,000 feet then decreasing linearly to 27°C at 20,000 feet pressure altitude using primary fuels.

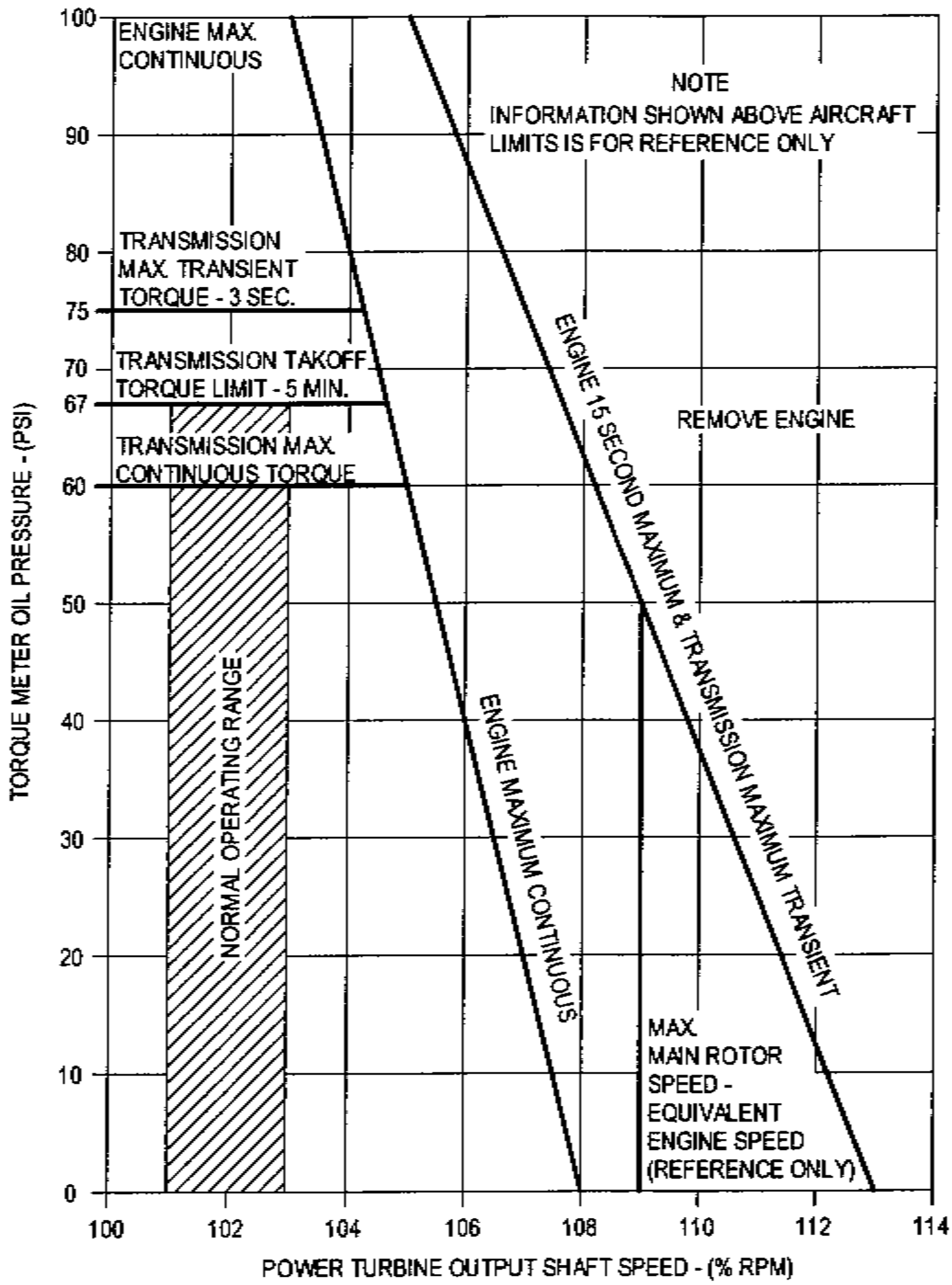


FIGURE 1-2. MAXIMUM ALLOWABLE TORQUE AND N_2

e. Fuel Operational Limits

(1). Primary Fuel is defined as fuel conforming to MIL-DTL-5624 (formerly MIL-T-5624) Grade JP-4 or JP-5, MIL-DTL-83133 (formerly MIL-G-83133) Grade JP-8, and ASTM D1655 Jet A/A1, and ASTM D6615 Jet B.

NOTE

At ambient temperatures below 4°C (40°F), all fuels used shall contain Anti-Icing Additive conforming to MIL-DTL-85470. The Anti-Icing Additive shall be added to all commercial fuel, not already containing an anti-icing additive, during refueling operations. Refueling operations shall be accomplished in accordance with accepted commercial procedures. Commercial product PRIST® HI-FLASH™ conforms to MIL-DTL-85470.

(2) Emergency Fuel is defined as ASTM D910 (formerly MIL-G-5572) AVGAS grade 80/87 or grade 100/130 with a maximum of 2.0 ml/gal lead content. ASTM D910 AVGAS fuel containing tricresyl-phosphate (TCP) shall not be used. Use of emergency fuel shall be limited to six (6) hours total engine operating time between overhaul (TBO). Entry in the aircraft log book is required. Practice autorotations are prohibited using emergency fuel.

f. Lubrication System Limits

(1) Oil Specification. Approved oils for the engine are MIL-PRF-23699C or subsequent (formerly MIL-L-23699C) or MIL-PRF-7808G or subsequent (formerly MIL-L-7808).

(2) Oil Pressure Limits

94.2% N_1 and above	115 - 130 PSI
78.5% - 94.2% N_1	90 - 130 PSI
Below 78.5% N_1	50 - 130 PSI

1-10. Starter Limits

Starter limits are as follows:

a. If no TOT within the first 20 seconds:

EXTERNAL POWER	BATTERY POWER
25 seconds ON	40 seconds ON
30 seconds OFF	60 seconds OFF
25 seconds ON	40 seconds ON
30 seconds OFF	60 seconds OFF
25 seconds ON	40 seconds ON
30 minutes OFF	30 minutes OFF

b. If rise in TOT occurs during the first 20 seconds:

EXTERNAL OR BATTERY POWER
1 minute ON
1 minute OFF
1 minute ON
1 minute OFF
1 minute ON
30 minutes OFF

NOTE

Below 4°C (40°F) the starter engage time limits do not apply.

SECTION IV. OPERATIONAL LIMITS

1-11. Airspeed Limits

a. Vne. The airspeed limits are a function of pressure altitude, temperature, takeoff gross weight, and takeoff center of gravity. Figure 1-3 presents the velocity never exceed (Vne) of the aircraft. The maximum sea level Vne of the aircraft at 2,850 pounds gross weight is 122 KIAS with doors on or off.

NOTE

In order to avoid excessive rates of descent in autorotation, it is recommended that autorotation speeds be limited to 85 KIAS or V_{NE}, whichever is lower.

b. Sideward and Rearward. The helicopter is limited to 35 knots sideward and rearward flight. There is no wind azimuth, relative to the nose, that is critical for directional control of the aircraft. Sideward and rearward flight has been demonstrated at 8,000 feet density altitude.

c. Flight With Doors Removed. There are no restrictions for flight with the doors removed, however, all loose objects and equipment within the cabin must be properly secured and the cushions for the unoccupied seat(s) must be removed or properly strapped down using the lap belts and shoulder harnesses. The rear bulkhead soundproofing must be checked for security and condition prior to flight and firm attachment to the airframe assured.

NOTE

When operating the aircraft with one or both doors removed, a loud buffeting may be encountered at speeds above 65 knots. Although this noise may be loud enough to be annoying, it does not effect the safety of flight of the aircraft.

1-12. Altitude Limits

The maximum approved operating altitude of the helicopter is 13,000 feet density altitude.

1-13. Load Limits

a. Weight. The maximum takeoff and landing gross weight of the helicopter is 2,850 pounds from sea level to 13,000 feet density altitude.

b. Center of Gravity. The Center of Gravity Limitations Chart is presented in Chapter 6. Weight/ Balance and Loading. The limitations are as follows:

(1) AFT CG is 141.5 in. at 2,850 lbs. gross weight expanding linearly to 143.0 in. for all weights at and below 2,500 lbs.

(2) FWD CG is 134.0 in. for all weights up to 2,200 pounds and decreasing linearly to 136.35 in. at 2,850 pounds gross weight.

c. Lateral Center of Gravity. The lateral center of gravity is expressed in terms of lateral offset moment. The lateral offset moment limits are ±7,500 in-lbs.

d. The maximum allowable weight in the baggage box is 150 LB.

e. The maximum allowable weight on the baggage shelf behind the pilot's seat is 50 pounds.

1-14. Maneuvers

CAUTION

The engine is approved for operation at 90 degrees pitch up and down and zero (0) g for 10 seconds only. Dwelling at these conditions longer than 10 seconds can damage the engine.

a. Aerobatics. Aerobatic maneuvers, (over 90 degrees in pitch or roll), are prohibited.

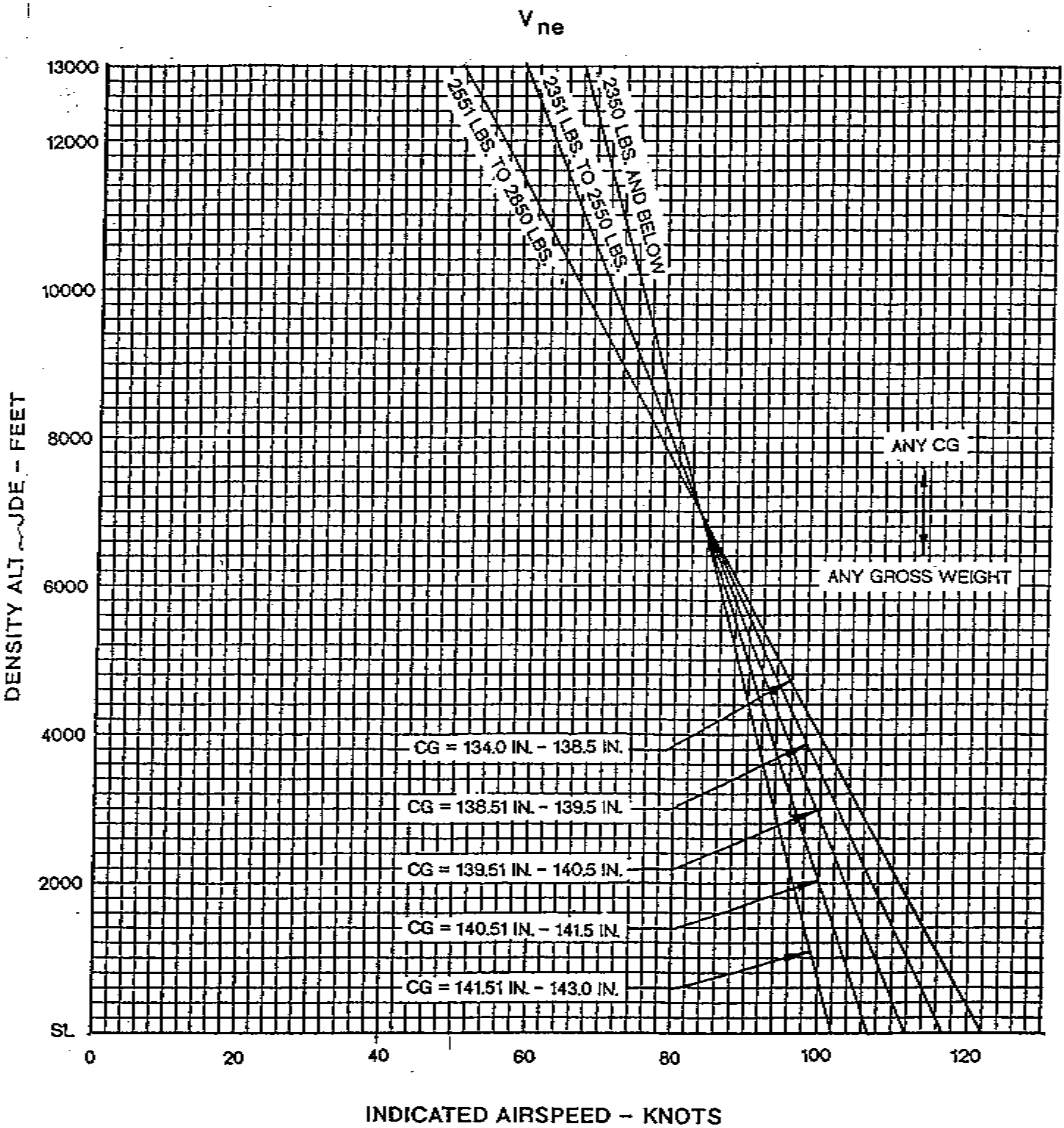


FIGURE 1-3. AIRSPEED OPERATING LIMITS

1-15. Environmental

a. Ambient Temperature. The maximum operational temperature is 114°F (45.5°C). The minimum operational ambient temperature is -25°F (-32°C).

b. All de-ice and anti-ice systems, including the Scavenge air for the particle separators, and engine anti-ice, must be turned on when flying in the presence of visible moisture at outside temperatures of 40°F or below and always during flight at night when the outside air temperature is 40°F or below.

c. Falling or Blowing Snow. Flight in falling and blowing snow is authorized provided the following conditions are met:

(1) Particle Separator scavenge air is ON continuously.

(2) Engine Anti-ice is ON continuously.

(3) Prior to initial takeoff and each subsequent takeoff the helicopter air and oil cooler inlets are inspected for possible accumulations of snow, slush, or ice and all accumulations are removed from the exterior of the particle separator and the cabin surface adjacent to and ahead of the inlet.

(4) Prior to initial takeoff and each subsequent takeoff the plastic particle separator eductor tubes on the aft end of the upper plenum are inspected for obstructions and snow and all such obstructions removed.

CAUTION

Restrict hover operations in heavy snow conditions (1/2 mile visibility or less) to 10 minutes or less per flight.

1-16. Restrictions in Use of Anti-torque Pedals

Avoid rapid pedal reversals (hard kicks) both on the ground and in flight.

1-17. Placards

a. Placards that are to be placed in view of the pilot are:

THIS HELICOPTER MUST BE OPERATED IN COMPLIANCE WITH THE OPERATING LIMITATIONS SPECIFIED IN THE FAA APPROVED ROTORCRAFT FLIGHT MANUAL

(and)

THIS HELICOPTER IS APPROVED FOR OPERATIONS UNDER DAY AND NIGHT VFR NON-ICING CONDITIONS ONLY

b. As optional equipment, on the overhead cabin structure below door jettison handles (if installed):

PULL TO JETTISON

c. Beneath the fuel filter port on the left side of the aircraft:

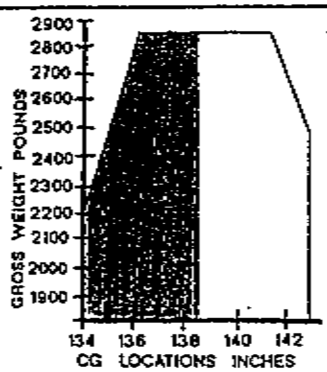
CAP. 90 U.S. GAL JP-4/JET-A **USE MIL-DTL-5624 / ASTM D1655** **AT TEMPERATURES BELOW 4°C (40°F) FUEL MUST CONTAIN MIL-DTL-85470 FUEL ADDITIVE** **(SEE RFM TABLE 8-3 FOR APPROVED ALTERNATE FUELS)**

NOTE

There are different useable fuel quantities depending on the helicopter serial number. The placard should read as follows for the listed aircraft:

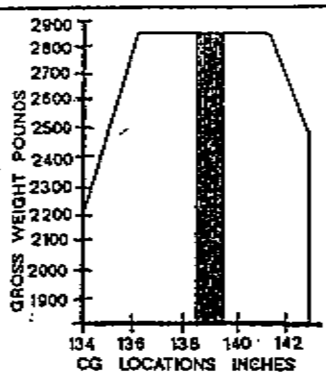
Serial Numbers: 5001 - 5012	89.7 Gallons
Serial Numbers: 5013 and subsequent	88 Gallons

d. Placards for the Vne (located overhead above the center of the forward wind screen).



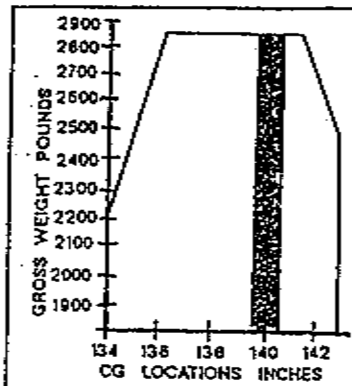
Vne-KIAS (KNOTS) ANY WEIGHT, 138.5 TO FWD LIMIT TAKEOFF CG, BELOW 7000' DA

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °F											
	-40	-20	0	20	40	50	60	70	80	90	100	110
SEA LEVEL	122	122	122	122	122	122	122	117	114	111	108	104
2000	122	122	122	122	116	111	108	104	101	97	94	91
4000	122	122	117	109	101	97	94	91	87	83		
6000	120	111	103	95	88	83	FLIP OVER TO Vne CARDS FOR ALTITUDES ABOVE 7000' DA					
8000	106	97	88	83								
10000	91	83										



Vne-KIAS (KNOTS) ANY WEIGHT, 139.5-138.6 TO TAKEOFF CG, BELOW 7000' DA

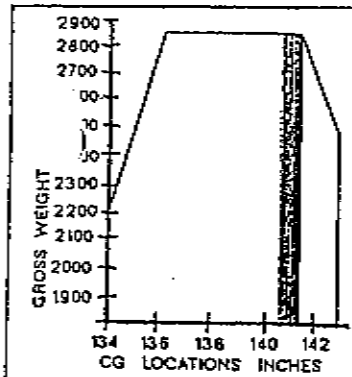
PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °F											
	-40	-20	0	20	40	50	60	70	80	90	100	110
SEA LEVEL	117	117	117	117	117	117	117	114	110	107	103	102
2000	117	117	117	117	111	108	105	100	98	95	92	89
4000	117	117	113	106	99	95	92	89	86	83		
6000	115	108	100	94	87	83	FLIP OVER TO Vne CARDS FOR ALTITUDES ABOVE 7000' DA					
8000	103	95	88	83								
10000	90	83										



Vne-KIAS (KNOTS) ANY WEIGHT, 139.6 TO 140.5 TAKEOFF CG, BELOW 7000' DA

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °F											
	-40	-20	0	20	40	50	60	70	80	90	100	110
SEA LEVEL	112	112	112	112	112	112	112	109	106	104	100	99
2000	112	112	112	112	107	104	102	98	96	93	91	88
4000	112	112	108	102	96	93	91	88	85	83		
6000	110	104	98	92	86	83						
8000	100	94	87	83								
10000	89	83										

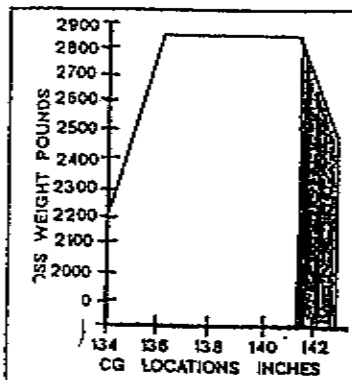
FLIP OVER TO Vne CARDS FOR ALTITUDES ABOVE 7000' DA



Vne-KIAS (KNOTS) ANY WEIGHT, 140.6 TO 141.5 TAKEOFF CG, BELOW 7000' DA

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °F											
	-40	-20	0	20	40	50	60	70	80	90	100	110
SEA LEVEL	107	107	107	107	107	107	107	104	102	99	97	96
2000	107	107	107	107	103	100	98	95	94	91	89	87
4000	107	107	104	99	94	91	89	87	84	83		
6000	105	100	95	90	85	83						
8000	97	91	86	83								
10000	88	83										

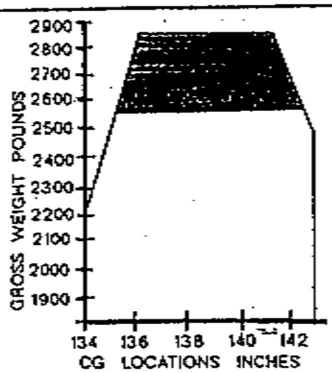
FLIP OVER TO Vne CARDS FOR ALTITUDES ABOVE 7000' DA



Vne-KIAS (KNOTS) ANY WEIGHT, 141.6 TO 143.0 TAKEOFF CG, BELOW 7000' DA

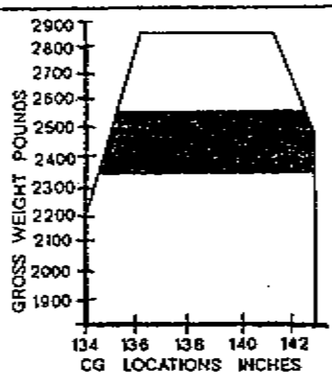
PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °F											
	-40	-20	0	20	40	50	60	70	80	90	100	110
SEA LEVEL	102	102	102	102	102	102	102	100	98	96	94	93
2000	102	102	102	102	99	96	95	93	91	89	88	86
4000	102	102	99	95	91	89	88	86	84	83		
6000	100	96	93	89	85	83						
8000	94	90	86	83								
10000	86	83										

FLIP OVER TO Vne CARDS FOR ALTITUDES ABOVE 7000' DA



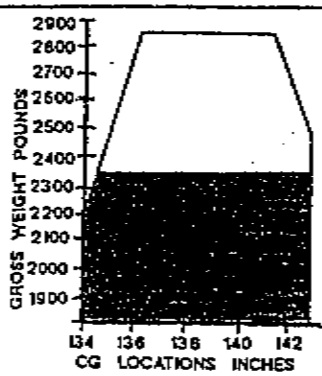
Vne-KIAS (KNOTS) ANY C.G., 2850-2550 lb. TAKEOFF GROSS WT., ABOVE 7000' DA

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °F											
	-40	-20	0	20	40	50	60	70	80	90	100	110
4000	FLIP BACK TO CHARTS FOR Vne BELOW 7000' D.A.									83	80	77
6000						83	80	76	73	70	67	63
8000				83	74	71	67	63	60	57	54	51
10000		83	75	67	60	56	53	50				
12000	77	69	61	54	DENSITY ALTITUDES IN THIS AREA ARE ABOVE 13000'							
14000	63	55										



Vne-KIAS (KNOTS) ANY C.G., 2549-2350 lb.TAKEOFF GROSS WT., ABOVE 7000' DA

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °F											
	-40	-20	0	20	40	50	60	70	80	90	100	110
4000	FLIP BACK TO CHARTS FOR Vne BELOW 7000' D.A.									83	81	79
6000						83	81	78	76	73	71	69
8000				83	76	74	71	69	66	63	61	58
10000		83	77	71	66	63	61	58				
12000	78	73	66	61	DENSITY ALTITUDES IN THIS AREA ARE ABOVE 13000'							
14000	68	62										



Vne-KIAS (KNOTS) ANY C.G., 2349-1900 lb.TAKEOFF GROSS WT., ABOVE 7000' DA

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °F											
	-40	-20	0	20	40	50	60	70	80	90	100	110
4000	FLIP BACK TO CHARTS FOR									83	82	80
6000	Vne BELOW 7000' D.A.					83	82	80	78	76	75	73
8000				83	78	77	75	73	71	69	68	66
10000		83	79	75	71	69	68	67				
12000	80	76	72	68								
14000	73	69										

DENSITY ALTITUDES IN THIS AREA ARE ABOVE 13000'

e. Placard for the baggage compartment:

MAX ALLOWABLE CARGO 150 LBS

OBSERVE C.G. AND GROSS WEIGHT LIMITATIONS

f. Placard on baggage shelf behind pilot's seat:

MAX. LOADING – 50 LBS.

BAGGAGE MUST BE SECURED PRIOR TO TAKEOFF AND LANDING

g. When optional altimeter static source is installed (located above the forward wind screen):

ALTERNATE STATIC SOURCE ALTIMETER CORRECTION		
INDICATED AIRSPEED (KNOTS)	ADD TO ALTIMETER READING	
	WINDOWS CLOSED (FEET)	WINDOWS OPEN (FEET)
40	+5	0
50	+5	-15
60	-10	-35
70	-25	-55
80	-40	-75
90	-60	-95
100	-75	-115
110	-95	-140
120	-115	-170

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 2

NORMAL PROCEDURES

SECTION I. FLIGHT PLANNING

2-1. Flight Planning

Flight planning begins when the flight is assigned and extends to the preflight check of the helicopter. It includes, but is not limited to, checks of operating limitations and restrictions; weight, balance and loading, performance; publications; flight plan and crew and passenger briefings. The pilot in command shall ensure compliance with the contents of this manual that are applicable to the flight.

2-2. Operating Limits

The minimum, maximum, normal and cautionary operational ranges represent careful, aerodynamic and structural calculations, substantiated by flight test data. These limitations must be adhered to during all phases of the flight. Refer to Chapter 1, OPERATING LIMITS, for detailed information.

2-3. Weight, Balance, and Loading

The helicopter must be loaded, cargo and passengers secured, and weight and balance verified in accordance with Chapter 6, WEIGHT/BALANCE AND LOADING. The weight and center-of-gravity conditions must be within the limits prescribed by Chapter 1.

2-4. Performance

Refer to Chapter 4, PERFORMANCE DATA, to determine the capability of the helicopter for the entire flight. Consideration must be given to changes in performance resulting from variations in loads, temperatures, and pressure altitudes. A sample Performance Planning Card has been provided as Figure 4-1 for use in completing the flight plan and for reference throughout the flight.

SECTION II. OPERATING PROCEDURES AND MANUEVERS

2-6. General

This section pertains to normal procedures, and includes all steps necessary to ensure safe and efficient operation of the helicopter. Unique feel, characteristics and reaction of the helicopter during various phases of operation and the techniques and procedures used for taxiing, takeoff, climb, etc. are described, including precautions to be observed. Your flying experience is recognized; therefore, basic flight principles are avoided.

2-7. 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.

2-8. Checks

The checklist includes items for day and night flights, with annotative indicators immediately preceding the check to which they are pertinent: (N) for night operations only; and (O) to indicate a requirement if the equipment is installed.

2-9. Before Preflight Check

1. Publications – Check that the Airworthiness Certificate, FCC License (if required), Registration; the appropriate weight and balance Form F-511-5, and the 480 Operator's Manual are on board.

(O)2. Aircraft tiedowns, covers, grounding cables – Removed and stowed.

3. BATT switch – ON.

4. Fuel quantity – Check.

5. Lights – ON then OFF after check. Check landing, strobe anti-collision, position, and interior lights for condition and operation.

6. BATT switch – OFF.

7. Right Side Flight Controls – Check secure if installed. Check properly stowed if removed and check all covers for security.

8. Pilot/Co-pilot/passenger seats and restraints – Check condition and security.

9. Pedals – Adjust as required.

10. Cargo – Check loading and security

11. First aid kit – Check condition and security.

11. Fire extinguisher – Check for charge, condition, and security.

2-9.1 Preflight Check – Fuel Management

1 Left fuel tank drain – Drain sample into jar. Verify the fuel grade, check the cleanliness, and check that fuel is free of water.

WARNING

Sample the left and right fuel tank sumps before checking the low point drain.

NOTE

Aircraft should be level or slightly nose down. Rock the aircraft by moving the tail up and down to displace any water or contaminants to the low point drain. If water is found, rock the aircraft and re-sample. Check the other tank. Then check the low point drain.

2. Right fuel tank drain - Drain sample into jar. Verify the fuel grade, check the cleanliness, and check that fuel is free of water.

3. Low point drain – Secure and drain fuel sample into jar. Verify the fuel grade, check the cleanliness, and check that the fuel is free of water.

2-10. Exterior Check (Figure 2-1) - Cabin Left Side - Area 1

1. Forward landing gear – Check condition and security of fairings, tubes, skids, step, and skid shoes. Check oleo for proper inflation (para. 8-11).

(O)2. Cabin Door – Check condition, latch operation, and security.

3. Static port – Check unobstructed.

2-11. Aft Fuselage - Left Side - Area 2

1. Fuselage – Check condition as other items are checked.

2. Engine Compartment – Check

a. Fuel lines – Check for condition, security, and leaks.

b. Flight controls – Check for security.

c. Engine – Check for security of all air, oil and fuel lines and evidence of leaks.

d. Fire detection pressure loop – Check condition and security.

e. Electrical wiring – Check condition, security, and any evidence of short circuits or overheating.

f. Lower pulley bearings – Check condition and security.

g. Drive belt – Check condition and tension.

h. Tail rotor cable – Check condition, tension, and routing.

i. Engine fire curtain – Check condition and security.

j. Main rotor transmission oil filtration/cooling system (if installed) – Check filter assembly and visible oil lines for condition and oil leaks.

k. Overrunning clutch – If the overrunning clutch (ORC) cover is equipped with sight glass, check oil level in the sight glass. If the

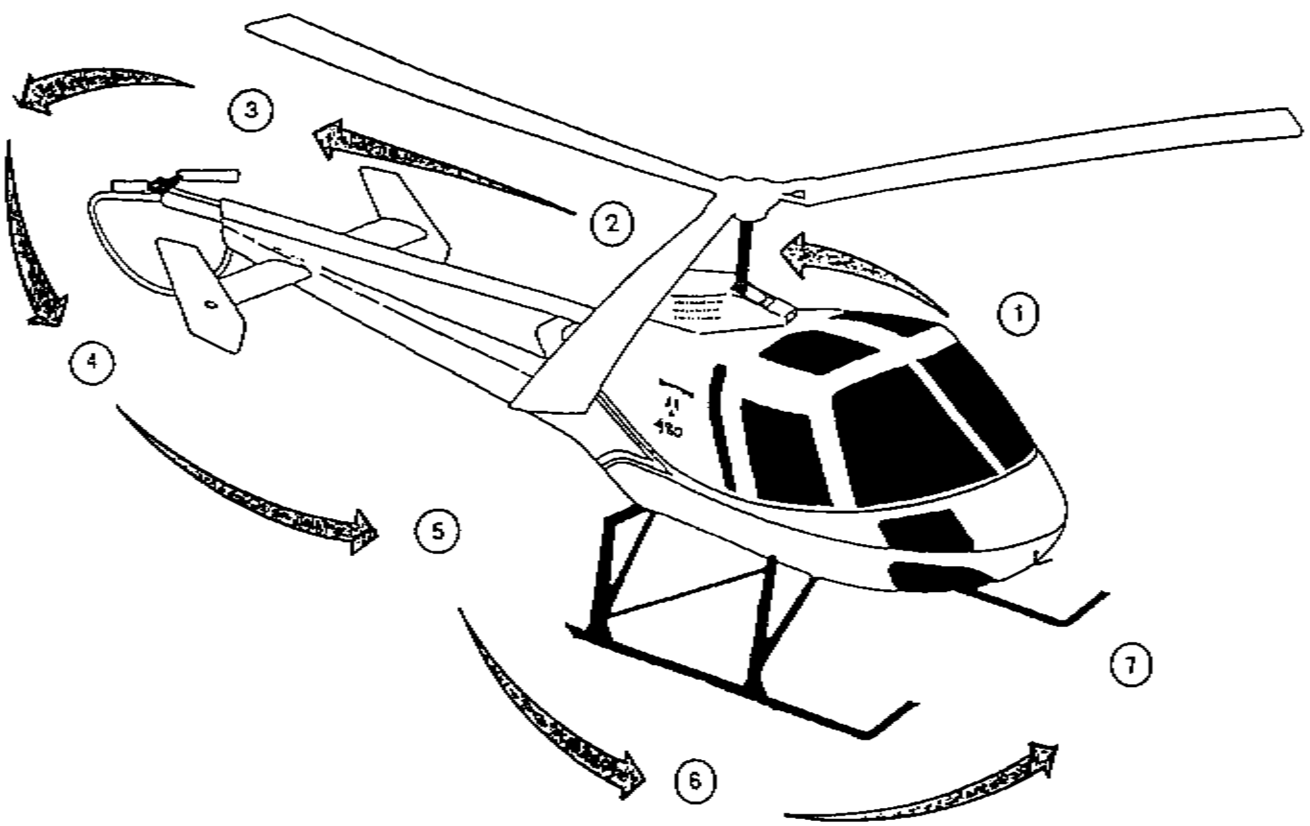


FIGURE 2-1. EXTERIOR CHECK

overrunning clutch (ORC) is equipped with a vented clutch oil reservoir, check oil level in the sight glass. The oil level in the ORC cover and the oil reservoir sight glasses should be the same. Service the ORC if no oil is visible in the sight glass(es) (para. 8-9).

(O)l. External fuel filter – Check impending bypass indicator.

(O)m. Cargo hook suspension cables – Check.

(O)n. Cargo hook – Check condition and security.

(O)o. Cargo hook manual release mechanism and electrical release wiring – Check.

(O)p. Cargo hook electrical release – Check.

(O)q. Cargo hook manual release – Check.

r. Engine compartment door – Secure.

3. Lower engine compartment access panels – Check security.

4. Left fuel tank – Check for leaks, check fuel quantity, and cap secured.

5. Engine inlet and plenum – Check clean and unobstructed.

6. Aft landing gear – Check condition and security of fairings, tubes, step, skids, and skid shoes. Ground handling wheels removed. Check oleo for proper inflation (para. 8-11).

7. Oil cooler air intake – Unobstructed.

8. Baggage compartment – Check cargo properly loaded and secured. Check battery for leakage, proper connection, and security if located in baggage box. Close and lock door.

(O)9. Snowshoes – Check condition and security.

2-12. Tailcone - Left Side - Area 3

1. Tailcone – Check condition as other items are checked.

2. Static port – Check unobstructed.

3. Antennas – Check condition and security.

4. Horizontal stabilizer – Check condition and security.

5. Vertical stabilizer – Check condition and security.

6. Position and strobe lights – Check condition and security. Check security of light shield.

7. Tail rotor drive shaft – Check cover closed and secure.

8. Tail rotor hub – Check security. Check condition of teeter stop bumpers.

9. Tail rotor blades – Check security. Check for cracks or bond separations. Check strike tabs for evidence of strike.

10. Pitch change mechanism – Check condition and operation. Check pitch links for binding or looseness.

11. Tail rotor control cables – Check condition, tension, and security.

2-13. Tailcone - Right Side - Area 4

1. Tail rotor control cables – Check condition, tension, and security.

2. Tail rotor gearbox – Check for oil leakage and oil level. Check chip detector, and continuity sensor unit. Check for security of attachment.

3. Tail rotor guard – Check condition and security and evidence of strike damage.

4. Tailcone extension – Check condition and security.

(O)5. Vibration absorber – If installed, check condition and security.

6. Tailcone – Check condition as other items are checked.

7. Horizontal stabilizer – Check condition and security.

8. Vertical stabilizer – Check condition and security.

9. Position and strobe lights – Check condition and security. Check security of light shield.

10. Antennas – Check condition and security.

11. Static port – Check unobstructed.

2-14. Fuselage - Right Side - Area 5

1. Oil cooler exhaust – Check condition and unobstructed.

2. Aft landing gear – Check condition and security of fairings, tubes, step, skids, and skid shoes. Ground handling wheels removed. Check oleo for proper inflation (para. 8-11).

3. Engine Compartment – Check.

a. Fuel lines – Check for condition, security, and leaks.

b. Flight controls – Check for security. If installed, check condition and security of vibration absorber and lanyard.

c. Engine – Check for security of all air, oil and fuel lines and evidence of leaks.

d. Fire detection pressure loop – check condition and security.

e. Battery, starter, relays, and associated electrical wiring – Check condition, security, and any evidence of short circuits or overheating. Make sure battery is securely connected or all battery hardware is properly stowed.

f. Engine oil reservoir – Check condition, oil level, and cap secure. For an accurate indication, oil level should be checked within 15 minutes of engine shutdown.

g. Oil Lines – Check for condition, security and leaks.

h. Lower pulley restraint rods – Check condition and security.

i. Scavenge oil filter – Check impending bypass indicator retracted. If out, log in aircraft log book. It can be reset once. If it pops a second time maintenance action is required.

j. Engine fire curtain – Check condition and security.

k. Throttle position – Check against the minimum position stop.

(O) l. Cargo hook suspension cables – Check.

m. Engine compartment door – Secure.

4. Engine Exhaust and eductor – Check condition and security.

5. Lower engine compartment access panels – Check security.

6. Main rotor transmission oil level – Check oil sight gauge at least half full (para. 8-7).

(O)7. Snowshoes – Check condition and security.

2-14.1 Fuselage Top Area (Check From Steps):

1. Engine inlet and plenum – Check clean and unobstructed.

2. Upper transmission area – Check ram air scoop and upper transmission area unobstructed. Check fuel cell vent lines for condition and security.

3. Main rotor system

a. Main rotor shaft – Check condition.

b. Main rotor blades – Check security and condition, no bond separations, cracks or corrosion. Main rotor retention pins secured.

c. Check main rotor hub for security of all fasteners, no cracks or obvious damage.

d. Main rotor pitch links – Check for binding or looseness.

e. Main rotor dampers – Check for security and no leakage.

4. Upper pulley area – Check unobstructed. Check main transmission oil level and tail rotor shafting. Check main rotor transmission oil sight gage at least half full. Check upper pulley fan unobstructed. Check tail rotor shafting, flex couplings, and hangar bearings for condition, security and lubrication.

2-15. Fuselage - Cabin Right Side - Area 6

1. Static port – Check unobstructed.

(O)2. Cabin Door – Check condition, latch operation, and security.

3. Forward landing gear – Check condition and security of fairings, tubes, skids, step, and skid shoes. Check oleo for proper inflation (para. 8-11).

2-16. Fuselage - Front Area - Area 7

1. Windshield – Check condition.

2. Pitot tube – Check unobstructed; Drain hole – clean and unobstructed, cotter pin free.

3. Landing light – Check condition.

4. Fuselage underside – Check condition.

(O)5. Main rotor blade tape – if leading edge blade tape is installed, check condition of tape on all three blades. Check for holes or openings in the tape, air bubbles under the tape, and separation areas along the edges of the tape.

2-17. Before Starting Engine

1. KEY – IN and ON.

2. Passenger briefing – Complete as required. Refer to Section III for passenger briefing.

3. Seat belts and shoulder harnesses - Fastened and tightened.

4. Inertial reel – Check operation.

5. Collective friction – OFF.

6. Flight controls – Check full travel. Center cyclic and pedals. Collective pitch unobstructed and down.

7. Collective friction – ON.

8. Throttle – Check then idle cutoff. Move to full open, then move back to the idle stop; press the idle stop release button and close to the idle cutoff position.

9. Circuit breakers – All IN.

(O)10. Avionics Master Switch(s) – OFF.

11. Switches – All OFF.

12. Systems instruments – Check for static indications and markings.

13. Flight instruments – Check indications and set as necessary.

14. Fuel valve – ON.

(O)15. Static Air Switch - STANDARD.

16. N_2-N_R-TOT Switch – Turn to BATT and note needle movement, tachometer and TOT indication. Then turn to MAIN and note tachometer and TOT needles are below zero. Leave the N_2-N_R-TOT switch on MAIN.

NOTE

On helicopters equipped with an 8-Ohm "PASSIVE" TOT System, the switch is labeled "N_2/N_R" and the TOT needle should not respond during this check.

(O)17. Magnetic compass slave switch – Check in Slave position (if installed).

18. Select correct V_{NE}/C.G. placard.

NOTE

V_{NE} is based on a combination of pressure altitude and temperature at flight conditions and take-off gross weight and take-off c.g. Proper determination of take-off gross weight and c.g. is required to determine the appropriate V_{NE} envelope.

19. Ground power unit – Connected for start as required.

20. BATT switch – ON. Check the ENG CHIP, MAIN XMSN CHIP, and TAIL CHIP segments illuminate and remain on for approximately five seconds then go out to indicate proper continuity in all three chip detector systems.

(O)21. Attitude indicator(s) – Reset by pulling the Fast Erect knob.

22. Warning lights – Check for the illumination of the ROTOR RPM and ENGINE OUT warning lights.

23. Caution panel – Test. Check that the MASTER CAUTION light, FIRE WARNING light, and all of the 15 segments in the segmented caution panel illuminate. Release the switch and check that all lights go out except the ENGINE OUT and LOW ROTOR warning lights and DC GEN and ENG OIL PRESS caution lights. The three chip lights should come back on and remain on for approximately five seconds then go out to indicate proper continuity in all three chip detector systems.

24. Clock – Checked and set.

(O)25. Digital Fuel Quantity – Check. Enter new fuel quantity, if required, as follows:

a. Determine total fuel quantity on board from the fuel quantity gauge and the fueling records.

b. Press the center toggle switch to the left (fuel remaining) position. If it agrees with the quantity on board, release the toggle switch and press "ENTER".

c. If it reads less than the quantity on board, hold the center toggle switch to the left and simultaneously press the "enter" button and hold. Fuel quantity will increment.

d. Release all switches when the digital display reads the correct amount then press "ENTER".

e. If it reads more than the quantity on board, hold the center switch to the right and press the "ENTER" button and hold both. The fuel quantity will decrement.

f. Release all switches when the digital display reads the correct amount. Then press "ENTER"

26. Engine out/low rotor audio - Test by releasing the collective friction, raising the collective until both audio alarms are heard, then lowering the collective to full down and resetting the collective friction.

27. Throttle – Checked closed.

28. Cyclic trim – Check by displacing the cyclic trim switch coolie hat each direction - forward, aft, left, and right - for a few seconds to determine that the motors run the proper direction and reverse properly. Then center the cyclic.

29. Anti-collision strobes – ON.

(N)30. POS LTS switch – ON as required.

2-18. Starting Engine

1. Exhaust area – Check area is clear and free of combustible foliage.

2. Rotor blades – Check clear and untied.

3. Verify TOT.

NOTE

If the TOT is above 150°C, the pilot may elect to motor the engine with the throttle off until the TOT is below 150°C, prior to beginning this engine start sequence. If the engine is equipped with a start counter, this will count as a "START" but can be deducted in the engine records in accordance with the Allison 250-C20 Series Operation and Maintenance Manual.

4. Engine – Start as follows:

a. Starter switch – Press and hold. Simultaneously start the clock stop watch function to time the start to 58% N_1.

b. TOT – Below 150°C. Motor engine as necessary to lower TOT below 150°C.

c. Throttle – Open quickly to the idle stop after the N_1 RPM passes through 12-15%. Observe recommended minimum N_1 speeds as noted below:

OAT (Outside Air Temp)	Minimum N_1 Speed
7°C and above	15%
7°C down to -18°C	13%
-18°C and below	12%

NOTE

It is not necessary to wait for the N_1 to peak.

d. Monitor TOT for over temperature conditions. Refer to Chapter 1 for limitations.

e. Starter switch – Release at 58% N_1. Note elapsed time for start. Observe the starter limitations prescribed in Chapter 1 and the average engine starting time shown in Chapter 9.

f. Engine oil pressure – Check.

g. Gas producer – Check 59 - 65% N_1.

h. N_2 – Check stabilized.

CAUTION

If the main rotor is not moving when 30% N_1 is reached, abort the start and make an entry in the aircraft log book.

5. Ground power unit – Disconnect (if used).

CAUTION

Check that the ground power unit is disconnected prior to turning the Generator switch ON.

6. GEN switch – ON, check DC GEN caution light out, and Volt/Ammeter indicates a load. Wait until the ammeter load decreases below the redline before turning any other electrical system on.

(O)7. Avionics Master Switch – ON.

2-19. Engine Runup

1. Engine – Stabilize for one minute before accelerating to the flight RPM operating range.

NOTE

If the engine has been shut down for less than 15 minutes prior to this start, the one minute stabilization time is not necessary.

2. Throttle – Slowly increase to full open. N_2 should stabilize between 88% - 103%.

NOTE

N_2 should be stabilized before advancing throttle to full open. Keep torque below 30 PSI while advancing the throttle to avoid compressor surges.

3. GOVERNOR INCR/DECR switch – Set engine RPM at 97±1% N_2.

4. Engine and transmission indications – Check.

5. ENG ANTI-ICE – Check by pulling the handle out fully; check for a rise in TOT, then push the handle back in to the OFF position and check for a decrease in TOT. Set as required.

(O) 7. DEFOG and HEAT - Check by turning both full ON; check for a rise in TOT; then set as required.

(O) 8. PITOT HTR (if installed) - Check by switching PITOT HTR switch to ON; check for an increase in DC Amps; then set as required.

9. Avionics - Set.

10. Altimeter - Set.

(O) 11. Heading indicator(s) - Check that the heading indicator(s) align properly and the heading corresponds with the magnetic compass. Set heading indicator as required.

(O) 12. Doors - Secured for flight.

13. Seat belts and shoulder harnesses - Secured for flight.

NOTE

Seat belts in un-occupied seats must be properly stowed to prevent interference with flight controls, etc.

14. Flight controls - Check flight controls for correct response.

15. Collective friction - Set as desired just prior to take-off.

2-20. Takeoff to a Hover

With the cyclic control in a neutral position, increase the collective pitch with a smooth, positive pressure until the desired hovering height is reached. Apply tail rotor pedal pressures to maintain heading as collective pitch control is increased. As the helicopter leaves the ground make minor corrections with cyclic control to ensure a vertical ascent and apply pedal pressures as necessary to maintain directional control. As the desired hover height is reached, adjust the flight controls as necessary to stabilize the helicopter at that height.

2-21. Hovering Turns

Apply pressure on the desired tail rotor pedal to begin the turn, using pressure and counterpressure on pedals as necessary to maintain constant rate of turn. Coordinate cyclic control to maintain the desired position over the selected pivot point while maintaining height with collective pitch control.

2-22. Sideward and Rearward Hovering Flight

From a stabilized hover, apply cyclic control pressure in the desired direction of flight to begin sideward or rearward movement. Maintain the desired heading with the pedals and height with the collective. The speed should not exceed that of a brisk walk. To return to a stationary hover, apply cyclic pressure opposite the direction of movement while coordinating collective pitch and pedals to maintain the desired height and heading.

2-23. Hover Taxi

From a stabilized hover, apply forward cyclic pressure to begin movement. Maintain the desired heading with the tail rotor pedals and height with the collective. The speed should not exceed that of a brisk walk. Changes in direction should be made primarily with pedal control to avoid excessive bank angles. To stop the forward movement, apply aft cyclic pressure while coordinating collective and pedals to maintain the desired height and heading.

2-24. Cyclic Trim

As required.

2-25. Hover Check

Perform the following checks at a hover:

1. Flight controls - Check flight controls for correct response.

2. Engine and transmission instruments - Check.

3. Flight instruments - Check as required.

a. Altimeter and IVSI - Check for proper indications of climb and descent.

b. Slip indicator - Ball free in the race.

(O) c. Turn needle, heading indicator, and magnetic compass - Check for proper turn indications left and right.

NOTE

Hover turns in excess of 30 degrees per second will cause the RMI/HSI compass system (if installed) display of heading to be inaccurate.

(O) d. Attitude indicator - Check for

proper indications of nose high and low, and banks left and right.

e. Airspeed indicator - Check airspeed.

4. Engine power - Check. The power assurance check will allow the pilot to determine if sufficient power is available for takeoff and to achieve the performance calculated during the preflight preparation. The check is performed by establishing a stable hover and recording the pressure altitude, OAT, torque, and TOT. The actual TOT is then compared with the TOT determined from the power assurance check chart in Chapter 4. If the actual TOT is less than or equal to the chart TOT the pilot is assured that the helicopter will achieve flight manual calculated performance. As a final check, the actual torque required to hover is then compared with the predicted values from the performance chart in Chapter 4.

2-26. Before Takeoff

Immediately prior to takeoff, the following checks shall be accomplished:

1. N_2 - 103%

2. Systems - Check engine, transmission, electrical, and fuel systems indications.

3. Fuel - Check quantity.

(O) 4. Communications and navigation radios - Set.

(O) 5. Heading cross checked with wet compass.

(O) 6. Transponder - On as appropriate.

7. Crew, passengers, and unused seats - Check seat belts and shoulder harnesses fastened.

2-27. Normal Takeoff

Align the helicopter with the desired takeoff course at a stabilized hover of approximately 3 feet skid height or at an altitude permitting safe obstacle and terrain clearance. Smoothly apply forward cyclic pressure to begin acceleration into effective translational lift. As the helicopter begins its forward movement, additional collective pitch will be required to maintain altitude and forward and right cyclic trim will be required to maintain the cyclic forces near zero as the helicopter accelerates. Adjust the pedal pressure as necessary to maintain the desired heading. Control the rate of acceleration and direction of flight with cyclic and altitude with collective. Continue to accelerate at the required altitude until effective translational lift has been attained. Then, obstacles and terrain permitting, continue a level acceleration, maintaining a 5 to 10 foot altitude until achieving best rate of climb airspeed for the density altitude conditions. Establish a climb at the desired rate. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb. Refer to the height-velocity diagram in Chapter 4 for avoid areas.

A normal takeoff may be made from the ground by aligning the helicopter with the desired takeoff course on the ground and positioning the cyclic control slightly forward of neutral. Smoothly increase collective pitch to begin a climb to an altitude of approximately 3 feet (or an altitude permitting safe obstacle and terrain clearance) while simultaneously accelerating the helicopter. Continue takeoff as in the above paragraphs.

2-28. Maximum Power Takeoff Profiles

A takeoff that demands maximum performance from the helicopter may become necessary because of various combinations of heavy helicopter loads, restricted performance due to high density altitudes, barriers that must be cleared and other terrain features. The decision to use either of the following takeoff techniques must be based on an evaluation of the conditions and the helicopter performance.

a. Coordinated Climb. Align the helicopter with the desired takeoff course at a stabilized hover of approximately 3 foot skid height. Apply forward cyclic pressure smoothly and gradually while simultaneously increasing collective pitch to begin a coordinated acceleration and climb. Adjust pedal pressure as necessary to maintain the desired heading. Maximum torque available should be applied without exceeding helicopter limits and the attitude adjusted to accelerate to 48 knots at 10 feet. The climbout is continued at that power setting accelerating and climbing to achieve 65 KIAS at 60 feet altitude, then 65 KIAS is maintained until reaching 300 feet above ground level (AGL). After reaching 300 feet AGL, adjust the helicopter attitude to establish the best rate of climb airspeed and then adjust the collective and attitude as required to maintain a climb at the desired rate. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb. Takeoff may be made from the ground by positioning the cyclic control slightly forward of neutral prior to increasing the collective pitch.

b. Level Acceleration. Align the helicopter with the desired takeoff course at a stabilized hover of approximately 3 feet skid height. Apply forward cyclic pressure smoothly and gradually while simultaneously increasing collective pitch to begin an acceleration at approximately a 10 foot skid height. Adjust pedal pressure as necessary to maintain the desired heading. Maximum torque available should be applied without exceeding helicopter limits prior to accelerating through effective translational lift. Additional forward cyclic pressure and trim will be necessary to allow for level acceleration to the desired climb speed. Approximately 5 knots prior to reaching the desired climb airspeed, gradually release forward cyclic pressure and allow the helicopter to begin a constant airspeed climb. After reching 300 feet AGL adjust the helicopter attitude to achieve best rate of climb airspeed and then adjust the collective to establish a climb at the desired rate. Continuous coordinated application of control pressures is necessary to maintain trim, heading, flight path, airspeed, and rate of climb. Takeoff may be made from the ground by positioning the cyclic control slightly forward of neutral prior to increasing collective pitch.

c. Comparison of Techniques. Where the two techniques yield the same distance over a fifty foot obstacle when the helicopter can barely hover OGE, the coordinated climb technique will give a shorter distance over lower obstacles and the level acceleration technique will give a shorter distance over obstacles higher than fifty feet. As hover capability is decreased the level acceleration technique gives increasingly shorter distances than the coordinated climb technique. In addition to the distance comparison, the main advantages of the level acceleration technique are: (1) It requires less or no time in the avoid area of the height-velocity diagram; (2) performance is more repeatable since reference to attitudes which change with loading and airspeed is not required; (3) at the higher climbout speeds the transition to autorotation should be more easily accomplished. The main advantage of the coordinated climb technique is that the angle of climb is established early in the takeoff and more distance and time are available to abort the takeoff if the obstacle cannot be cleared. Additionally, large attitude changes are not required to establish the climb airspeed.

2-29. Crosswind Takeoff

A crosswind takeoff does not require a significantly different technique than a takeoff into the wind. The primary difference is the requirement to hold the cyclic into the wind to prevent drift. For right crosswinds, additional power is required because of more left pedal being applied to maintain the desired heading.

2-30. Climb

After takeoff, select the airspeed and power necessary to clear obstacles. When obstacles are cleared, adjust the airspeed and power as desired at or above the maximum rate of climb airspeed. Refer to Chapter 4 for recommended airspeeds.

2-31. Cruise

When the desired cruise altitude is reached, adjust the power as necessary to maintain the desired airspeed. Refer to chapter 4 for recommended airspeeds, power settings, and fuel flow.

2-32. Descent

Adjust power as necessary to attain and maintain the desired airspeed and rate of descent. Refer to Chapter 4 for power requirements at selected airspeeds and rates of descent.

2-33. Before Landing

Prior to landing the following checks shall be accomplished:

1. N_2 - 103%

2. Systems - Check engine, transmission, electrical, and electrical indications.

3. Fuel – Check quantity.

4. Crew and passengers – Check.

5. Landing lights – As required.

2-34. Approach and Landing

1. Normal Approach. The approach begins by adjusting power as required to establish an approach angle of approximately 8 to 10 degrees at an airspeed above the minimum rate of descent airspeed specified in Chapter 4. Maintain the entry airspeed until the apparent ground speed and rate of closure appear to increase. From this point, progressively decrease the rate of descent and forward speed to stop all forward movement at approximately a 3 foot hover (or continue to the ground). As forward speed decreases below effective translational lift it will be necessary to gradually and smoothly increase collective pitch to terminate the approach. Refer to paragraph 2-35, Landing From A Hover. Refer to Chapter 4 for airspeeds, rates of descent and power requirements. Refer to the Height-Velocity Diagram, Chapter 4 for avoid areas during the approach.

2. Steep Approach. A steep approach is used as necessary to clear obstacles in the approach path. It is executed in the same manner as the normal approach except for the slower airspeeds that must be maintained throughout the approach. Approach angles may vary from that of a normal approach to a vertical descent. Because of the increased power requirements during termination, smooth and gradual collective pitch movements are very important.

3. Shallow Approach. A shallow approach is used as necessary when environmental or emergency requirements make it necessary to execute an approach at an angle less than that of a normal approach. It is executed in the same manner as a normal approach except that the deceleration may be more rapid. Approach angles may vary from that of a normal approach to approximately zero.

4. Running Landing. A running landing is used for some flight control malfunctions or for conditions where the helicopter cannot hover. The approach is shallow and flown at an airspeed that provides safe helicopter control. Airspeed is maintained as for a normal approach except that touchdown is made at an airspeed at or above effective translational lift. After ground contact is made, slowly decrease collective pitch to minimize forward speed. If braking action is necessary, the collective pitch may be lowered as required for quicker stopping.

2-35. Landing From a Hover

From a stabilized hover, decrease collective pitch control to begin a gradual descent to touchdown making necessary corrections with pedals and cyclic control to prevent movement over the ground. Upon ground contact, continue to decrease collective pitch control smoothly and steadily until the entire weight of the helicopter is on the ground. Apply cyclic control as necessary to level the rotor system. For slope landings, make sure that the aircraft shows no tendency to slide or roll as the aircraft is lowered.

2-36. After Landing

1. Landing lights – As required.

(O)2. Transponder – As required.

2-37. Engine Shutdown

1. Collective Pitch – Full down.

2. Collective friction – ON

NOTE

On the last flight of the day, perform a deceleration check as described in paragraph 2-49.

3. Throttle – Reduce to engine idle. Allow TOT to stabilize for two minutes. Check N_1 speed 59 to 65% N_1.

(O)4. Avionics – OFF (if installed).

5. All electrical switches – OFF except BATT, POS LTS, STROBES.

CAUTION

GEN switch must be OFF before closing throttle to shut engine down.

6. Throttle – Closed. Ensure that after shutdown TOT is stabilized below 400°C. Either a TOT over 400°C or a TOT of 400°C and still rising are indications of a possible residual fire in the engine. In either case press the starter switch with the throttle closed to motor the engine until the TOT is less than 200°C.

7. Lights – OFF (at night leave the lights on until the rotor stops for additional ground personnel safety).

8. BATT switch – OFF.

CAUTION

Do not drop the seat belt onto the floor. The heavy central latching mechanism may damage the honeycomb floor.

2-38. Before Leaving The Helicopter

1. Walk Around Inspection – Complete. Look for damage, and leaks, and check fluid levels as required.

2. Complete aircraft log book entries.

3. Secure helicopter.

2-39. Night Flight

Before takeoff it is imperative to ensure that all lights, instruments, and avionics equipment are functioning properly. Generally, interior lighting should be kept to the minimum amount which will still allow complete visibility of all instruments and gages. Excessive cockpit lighting decreases outside visibility. Avoid using landing lights when in thick haze, dust, snow, smoke, or fog as reflected light will reduce visibility and may affect depth perception. During ground operations, the helicopter should be hovered/taxied slowly because it is difficult to judge actual ground speed and excessive speeds may be developed without realizing it.

NOTE

Prior to night flight or for any flights the duration of which will extend past official sunset, the extended glare shields on both sides of the instrument panel and the one at the rear of the instrument panel shall be installed. The one on the right side of the instrument panel may be removed but only if the extended floor is installed covering the right chin window.

SECTION III. PASSENGER BRIEFING

2-40. Passenger Briefing

The following is a guide that should be used in accomplishing required passenger briefings. Items that do not pertain to a specific flight should be omitted.

a. Normal Procedures

(1) Entry and exit of aircraft

(2) Seating

(3) Seat belts (briefing is required by the FAA).

(4) Internal communications

(5) Security of equipment

(6) Smoking

b. Emergency Procedures

(1) Emergency exits

(2) Emergency equipment

(3) Emergency landing/ditching procedures.

SECTION IV. ADVERSE ENVIRONMENTAL CONDITIONS

2-41. Cold Weather Operations

Operation of the helicopter in cold weather or an arctic environment presents no unusual problems if the operators are aware of those changes that do take place and conditions that may exist because of the lower temperatures and freezing moisture.

NOTE

To ensure consistant starts at ambient temperatures below 4°C (40°F), it may be necessary to use JP-4, Jet B or a mixture of AVGAS and Jet A, Jet A1, or JP-5. See Chapter 8, "Handling, Servicing and Maintenance."

2-42. Cold Weather Inspection.

The pilot must be more thorough in the walk-around inspection when temperatures have been at or below 0 degrees C (32°F). Water and snow may have entered many parts during operations or in periods when the helicopter was parked unsheltered. This moisture often remains to form ice which will immobilize moving parts or damage structure by expansion and will occasionally foul electric circuitry. Protective covers afford protection against rain, freezing rain, sleet, and snow when installed on a dry helicopter prior to precipitation. Since it is not practical to completely cover an unsheltered helicopter, joints and those parts not protected by covers require closer attention, especially after blowing snow or freezing rain. Accumulation of snow and ice should be removed prior to flight. Failure to do so can result in hazardous flight due to aerodynamic and center of gravity disturbances as well as the introduction of snow, water, and ice into internal moving parts and electrical systems. The pilot should be particularly attentive to the main and tail rotor systems and their exposed control linkages. Also, as temperatures are reduced, the solubility of water in the fuel is markedly reduced. This results in water separating from the fuel and flowing to the lowest point in the tank, system, or accessory where it may later freeze. Under freezing conditions, it will form tiny ice crystals in the fuel which may be found impinged on the strainers, thus restricting fuel flow. Should this occur, there will be a drop in or loss of fuel pressure to the engine. The only remedy is to apply heat to the engine and fuel system components.

WARNING

If, at any time after engine start or during power application under low temperature conditions, the FUEL FILTER caution light comes on, the engine fuel filter may be blocked by ice crystals. If airborne, return and land, shut the engine down and apply pre-heat to the engine and the fuel system components to try to clear the condition. Drain fuel from all of the sump and system drains to ensure that all trapped water and crystals have been removed to the extent possible. As long as fuel will flow freely from the drains it can be assumed that the system is free from ice. Restart the engine. If the light re-illuminates, terminate engine operation and do not fly until the cause has been determined and corrected.

2-43. Cold Weather Checks.

a. Checks for temperatures below 0°C (32°F):

(1) Before exterior check - Perform check as specified in Section II.

(2) Exterior check - Perform exterior check as outlined in Section II, plus the following checks:

a. Check pitot drain hole clear and unobstructed, cotter pin free.

b. Check that all surfaces and controls are free of ice and snow.

NOTE

Contraction of the fluids in the helicopter systems at extreme low temperature causes indication of low levels. A check made just after the previous shutdown and carried forward to the walk-around check is satisfactory if no leaks are in evidence. Filling when the systems are cold soaked will result in an over fill condition with the possibility of forced leaks at seals.

c. Main Rotor - Check free of ice, frost, and snow, and check for blade feathering freedom.

d. Engine -

(1) Inspect inlet for possible accumulations of snow, slush, or ice. Accumulations must be removed from the top of the fuselage beneath the particle separators and forward of the inlet on the top of the cabin.

(2) Inspect the plastic particle separator eductor tubes at the rear of the upper plenum for obstructions and snow. A thin film of ice around the interior of each tube is acceptable. External ice adjacent to the eductor tube is also acceptable as long as the covers are free.

(3) Interior check - Perform check as specified in Section II.

(4) Engine starting check - Perform start and checks as outlined in Section II. (Use an external power unit if it is available.)

NOTE

During cold weather when starting the engine the indicated oil pressure may exceed the maximum limit. The engine should be warmed up at engine idle until the indicated engine oil pressure is below 130 PSI.

(5) Engine run up check - Perform the check as outlined in Section II.

WARNING

Control systems checks should be performed with extreme caution when the helicopter is parked on snow and ice. There is reduction in ground friction holding the helicopter stationary, controls are sensitive and response is immediate.

b. Engine Starting Without External Power. If a battery start must be attempted when the helicopter and battery have been cold soaked at temperatures below -26°C (-15°F) preheat the engine and battery if equipment is available and time permits. Preheating will result in a faster starter cranking speed which tends to reduce the hot start hazard by assisting the engine to reach a self sustaining speed.

2-44. Snow

Refer to Chapter 1 Operating Limitations for additional limitations and information for operations in falling and blowing snow.

a. Takeoff. A takeoff in the snow should be considered as a normal takeoff except the following precautions should be observed:

(1) Loose or powdery snow will restrict visibility.

(2) Before attempting to takeoff make sure that the landing gear skids are free and not frozen to the surface.

WARNING

Merely getting the helicopter light on the skids may not be a good indication that the skids are loose as only the oleos may be moving. To be sure that the helicopter is not frozen in place, pull enough power to get light on the skids and then yaw the aircraft a small amount with tail rotor pedal application to assure the freedom of movement. Be sure that the tail rotor is clear of any obstacles before performing this check.

(3) Ensure that both the ENGINE ANTI-ICE and the SCAVENGE AIR are full ON prior to takeoff.

WARNING

If the INLET AIR caution light illuminates as takeoff power is applied, abort the takeoff and investigate the cause of the caution light. This light is activated by a differential pressure switch that senses any inlet blockage sufficient to adversely effect engine power available.

b. Landing - Landing in snow may be considered as a normal landing except for the following precautions:

(1) If possible select an area free of loose or powdery snow so that visibility will not be restricted by blowing snow.

(2) Accomplish a landing to the ground. Limited visibility will result from swirling snow when hovering is attempted before making the touchdown.

(3) Anticipate loose powdery snow and crusts on top of the snow on all landings on snow.

(4) During landing the reference point should be kept forward and to the left so that it will be visible to the pilot at all times.

WARNING

When making takeoffs and landings on snow, make the takeoff or the landing all one continuous operation without extended hover, in order to reduce the white-out condition that results from the rotor downwash impingement on the snow surrounding the helicopter. This white-out will usually occur on loose snow and can cause the pilot to lose all reference with the ground or any object he is approaching. If the ground and/or the object being used as a reference becomes completely obscured, accomplish a go-around.

WARNING

When landing to snow covered terrain it will often be impossible to judge the slope of the underlying ground. As the helicopter touches down be prepared to contact uneven terrain by allowing the skids to contact the ground in the normal manner for the termination of an approach to the ground, but reserve the final movement of the collective to full down flat pitch until you are sure that both skids are firmly in contact with the ground. Lower the collective slowly and be prepared for some attitude adjustment, particularly if there is a crust on the surface of the snow. Stay prepared to add collective and to reposition if the underlying terrain proves unsuitable for landing.

2-45. Desert and Hot Weather Operations.

Typical problems encountered in desert operations are blowing dust and sand and high ambient temperatures.

a. Blowing dust and sand obscure vision and erode the leading edges of the rotor blades. All takeoffs and landings should be made from or to the ground.

b. High ambient temperatures effect the helicopter performance. Refer to Chapter 4.

WARNING

The engine is derated for this installation. As a result, throughout most of the operating envelope of the aircraft the usual power limit will be torque. When operating in high ambient temperature conditions, however, the engine will become the limiting factor and the pilot must be especially aware of the requirement to monitor the TOT and observe the appropriate time limits for operation of the engine in the yellow range for TOT. See Chapter 1, Operating Limitations.

CAUTION

When operating in dusty or sandy environment ensure that the particle separator scavenge air is ON for <u>ALL</u> takeoffs and landings. Otherwise severe engine erosion and subsequent loss of power will occur.

2-46. Icing Conditions

a. Intentional flight into any known icing conditions is prohibited. If icing conditions are encountered during flight, every effort should be made to exit the icing environment.

b. If icing conditions become unavoidable, the pilot should turn on the pitot heat (if equipped), windshield defog, engine anti-ice, and particle separator scavenge air systems. Switch the static system to alternate if equipped.

c. During flights in icing the following conditions may be experienced:

(1) Obscured forward field of view due to ice accumulation on the windscreens.

(2) Increase in one per revolution rotor vibrations ranging from mild to severe caused by asymmetrical ice shedding from the main rotor system. The severity of the vibration will depend upon the temperatures and the amount of ice accumulation on the blades when the

ice shed occurs. The possibility of an asymmetric ice shed occurring increases as the outside air temperature decreases.

(3) An increase in torque required to maintain a constant airspeed and altitude due to ice accumulation on the rotor system.

(4) Degradation of the ability to maintain autorotational rotor speed within the operating limits. If a 9% or greater torque pressure increase is required above the cruise torque setting used prior to entering icing conditions, it may not be possible to maintain autorotational rotor speed within operational limits should an engine failure occur.

(5) Loss of pitot and/or static system reference.

NOTE

Should the windshield defog fail to keep the windshield clear of ice, the side windows may be used for visual reference during landing. Sideslip during the approach to gain better visibility of the intended landing area.

d. Control activity cannot be depended upon to remove ice from the main rotor system. Vigorous control movements should not be made in an attempt to reduce low frequency vibrations caused by asymmetrical shedding of ice from the main rotor blades. These movements may induce a more asymmetrical shedding of ice, further aggravating helicopter vibration levels.

WARNING

Ice shed from the rotor blades and/or other rotating components presents a hazard to personnel during landing and shutdown. Ground personnel should remain well clear of the helicopter during landing and shutdown and passengers/crewmembers should not exit the aircraft until the rotor has stopped turning.

2-47. High Altitude Operations

High altitude operations pose no unusual problems to the operator with the sole exception of engine starts. In general, if the sea level setting on the engine start/acceleration adjustment is maintained, the starts may be excessively slow (60+ seconds) and cold. To ensure a proper start, the start/acceleration adjustment knob should be readjusted clockwise to increase the peak TOT of the start to 750 - 800 degrees celsius. (Refer to the Allison Engine Operation Manual.) For example, if the takeoff airport elevation is 10000 feet MSL, the acceleration knob should be rotated two to three clicks clockwise (but note that it needs to be turned back <u>before attempting</u> a start at lower altitude).

CAUTION

If the engine start exceeds 800 degrees celsius TOT, abort the start and adjust the start/acceleration knob one click counter clockwise for each 50 degrees celsius TOT.

2-48. High Altitude Cold Weather Operation.

In addition to the procedures described in paragraph 2-47, when the aircraft has cold soaked at temperatures below 0°C, it is best to preheat the engine before start. Experience has shown that the engine start/acceleration adjustment may be rotated an additional two clicks clockwise (over and above the adjustment for altitude) for the first start of the day, and while the engine is running, readjusted counter clockwise two clicks so that subsequent engine starts or restarts will remain within approved limits.

CAUTION

After the first cold start of the day, failure to remove the two-click clockwise start/acceleration knob adjustment that was used over and above the adjustment for altitude will result in the TOT exceeding starting limits for subsequent warm engine starts.

2-49. Deceleration Check

Make the following deceleration check during the shutdown for the last flight of the day.

1. Turn unnecessary electrical equipment OFF.

2. Turn the generator switch OFF.

3. Position the twist grip to full open, hold collective at flat pitch and stabilize N_2 at exactly 100% for approximately 15 seconds (beep as required).

CAUTION

During rapid throttle movements, make appropriate anti-torque pedal corrections to prevent the aircraft from turning on loose or slick surfaces.

4. Snap the twist grip to the IDLE position. Simultaneously start a time count using a stop watch or watch with a sweep second hand. Stop the time as the N_1 needle passes through 65%. The minimum allowable deceleration time is two seconds.

NOTE

Practice and/or retakes may be required before proficiency is obtained in timing the deceleration.

5. If deceleration time is less than two seconds, make two more checks to confirm the time. If the confirmed time is less than the minimum allowable time, refer to the Rolls Royce maintenance instructions.

6. If N_1 speed drops below 59%, or if a flame out is experienced during the deceleration check, do not make second attempt. Refer to the Rolls Royce maintenance instructions.

TABLE OF CONTENTS

TABLE OF CONTENTS

CHAPTER 3

EMERGENCY PROCEDURES

SECTION I. GENERAL

3-1. Helicopter Systems

This section describes the foreseeable helicopter and systems emergencies and presents the procedures to be followed. Emergency procedures are given in checklist form when applicable.

3-2. Definition of Terms

a. Immediate Emergency Actions. Those actions that must be performed immediately in an emergency procedure are underlined. These immediate emergency actions must be committed to memory.

NOTE

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

b. Urgency to Land.

1. Land Immediately - Perform a landing at the closest suitable landing site.

2. Land as Soon as Practicable - Land at the nearest suitable airport or landing facility.

c. Throttle - Closed. Shut down the engine by rotating the throttle to the fully closed position. This requires pressing and holding the idle stop release to move the throttle past the idle position.

3-3. After Emergency Action

After a malfunction of equipment has occurred, appropriate emergency actions have been taken and the helicopter is on the ground, an entry must be made in the remarks section of the aircraft log book describing the malfunction. The helicopter shall not be flown until corrective action has been taken.

3-4. Emergency Exit

To exit the cabin in the event of an emergency, first attempt to open the doors. If the doors will not open, break the windshield.

SECTION II. ENGINE

3-5. Engine Failure

The indications of an engine failure, either a partial power loss or a complete power loss are:

a. A left yaw caused by the drop in torque applied to the main rotor.

b. A drop in engine (N2) RPM.

c. The ENGINE OUT warning light and audio triggered by the N1 speed dropping below 58%.

d. A change in engine noise.

WARNING

Immediate reaction to an engine failure or power loss is essential. After immediate emergency actions have been accomplished verify the engine failure by cross checking all of the engine instruments.

Under partial power conditions, the engine may operate smoothly at reduced power or it may operate roughly and erratically with intermittent surges of power. In instances where a power loss is experienced without accompanying engine roughness or surging, the helicopter may sometimes be flown at reduced power to a favorable landing area; however, under these conditions the pilot should always be prepared for a complete power failure at any time. In the event that a partial power condition is accompanied by engine roughness, erratic operation, or power surging, close the throttle completely and perform an autorotational descent and landing.

After an engine failure in flight, an engine restart may be attempted if time and altitude permit. Because the exact cause of engine failure cannot be determined in flight, the decision to attempt the restart will depend on the altitude and time available, rate of descent, potential landing areas, and crew assistance available. Under ideal conditions, approximately 30-45 seconds is required to regain powered flight from the time the attempted start is begun if the start is commenced with an engine that is not windmilling. If the engine start button is depressed immediately after autorotation has been established, powered flight can usually be resumed within a matter of 20 to 25 seconds. There are two alternative types of restart that will be discussed below. The first is an immediate relight, the second is a restart from a full shutdown with the N1 below 15%.

NOTE

UNLESS THERE IS A REASON TO BELIEVE THAT THE ENGINE HAS FAILED DUE TO SOME OBVIOUS MECHANICAL FAILURE, ALWAYS ATTEMPT RELIGHT IMMEDIATELY AFTER ENTERING AUTOROTATION IF TIME AND ALTITUDE PERMIT.

3-6. Immediate Engine Relight

NOTE

Although there is a formal step by step checklist provided below for engine restart in flight, if circumstances such as terrain or flight condition require an immediate relight attempt, the procedure need only involve two steps;

1. Enter autorotation

2. ENGINE START BUTTON - Depress and HOLD

The throttle does not have to be retarded to idle if the elapsed time between failure and attempted relight has not exceeded 5 seconds. There will be a slight surge as the engine comes back on line but it will be well controlled and will not damage the engine or drive train. To control the engine surge as it returns to flight RPM, it is recommended that the rotor RPM be reduced to minimum, 334 RPM.

3-7. Engine Restart - During Flight

a. Autorotative glide - Establish

b. Attempt Start
1. Throttle - Closed

2. Starter Button - Depress

3. Throttle - Idle (N1 15% or greater)

4. TOT and N1 - Monitor

5. Starter Button - Release (at 58% N1)

6. Throttle - Advance to Full ON (N2/Nr needles rejoined)

7. Powered Flight - Resume

c. Land Immediately - After the engine is started and powered flight is reestablished, perform a power on approach and landing without delay if the engine was not intentionally shutdown.

3-8. Autorotation

a. General - The 480 is a very forgiving helicopter following engine failure because of the high inertia rotor system and the excellent flying qualities in the transition from powered to unpowered flight. Following engine failure, the pilot will not experience any unusual pitch or roll attitude excursions, and there will be only a mild tendency for the aircraft to yaw to the left until the pilot applies right pedal to coordinate the aircraft. When the collective is lowered there is no pronounced tendency for the nose to tuck and the cyclic migration is normal. Should the corrective response to the failure be delayed more than normal, there is a wide transient rotor RPM band available for corrective action, down to 300 rotor RPM.

WARNING

Rotor RPM recovery becomes very slow below 300 rotor RPM and the rotor RPM cannot be recovered below 240 rotor RPM. Never allow the rotor RPM to fall below 300 RPM in flight. In practice autorotations, if the rotor RPM falls below 300 rotor RPM, and the aircraft is not very close to touchdown (less than 1 foot), IMMEDIATELY bring the engine back on line to recover from the maneuver.

b. Autorotation Entry - In general, autorotation entry is initiated by lowering the collective and adjusting the cyclic to maintain attitude. This is true in almost all of the flight conditions except when the aircraft is very close to the ground, such as hover in-ground-effect and high speed flight in the avoid area of the H-V Diagram. (See the discussion of techniques for autorotations in those instances). Cyclic control is adjusted as necessary to control airspeed and flight path after engine failure occurs in forward flight.

Pedal pressure is applied as necessary to control aircraft trim and varies with airspeed and the amount of collective pitch applied at the time of engine failure.

Airspeed should be maintained between the minimum rate of descent and the maximum glide airspeeds at minimum power off rotor RPM, if conditions permit (see Chapter 4). Gliding the helicopter in autorotation out-of-trim will increase the rate of descent and decrease the glide distance, therefore correct tail rotor pedal control is important immediately after engine failure and during descent. If time permits during the autorotational descent, transmit a "Mayday" call, and set transponder to the appropriate emergency mode and code. The "Mayday" call must be made before the battery switch is turned OFF.

c. Descent. Minimum rate of descent and maximum glide are obtained at minimum rotor RPM. See Chapter 4, Performance, for appropriate airspeeds and further information.

3-9. Autorotation Profile

a. Terminology.

The terms used in the ensuing discussion are as follow:

1. Minimum Transient Rotor RPM. The minimum transient rotor speed can and may be as low as 300 rotor RPM during the initial response time following engine failure and during the initial recovery control inputs.

NOTE

Although operation below 334 RPM may be unavoidable during the initial stages of the autorotation, it should be minimized and immediate corrective action is required.

2. Minimum Rotor RPM. The minimum steady state rotor speed is 334 rotor RPM. This is the minimum allowable sustained rotor speed in steady flight, power Off.

3. Minimum Flare Airspeed. The minimum flare airspeed is 50 KIAS. This is the minimum airspeed that will allow effective tradeoff of forward airspeed for rotor RPM in the flare prior to touchdown and efficient energy conversion to arrest the rate of descent. A 25 rotor RPM increase can be achieved from a flare at 50 KIAS.

b. Profile Intercept.

Once the pilot has an understanding of the basic autorotation profile he can then determine what control inputs are necessary to maneuver the helicopter to intercept that profile following an engine failure. For example, if the airspeed is low, it will be necessary to lower the nose of the aircraft to increase the airspeed to achieve at least minimum flare airspeed. If the airspeed is high it must be decreased to at least the maximum glide airspeed. If the height above the ground is high, there is obviously time to refine the descent. If the height above the ground is low, then other considerations govern pilot actions such as where the aircraft is relative to the "knee" of the H-V diagram. The point of this discussion is to emphasize the necessity for the pilot to know where the aircraft is operating relative to the H-V Diagram at all times.

WARNING

The Height-Velocity Diagram (presented in figure 4-15) is published to assist the pilot in defining the limiting combinations of height and airspeed below which it will be impossible to maneuver the helicopter to intercept the autorotation profile prior to touchdown. The most likely outcome for an engine failure within the boundaries of the H-V diagram is a crash landing.

The procedures for profile intercept following an engine failure are therefore governed by the height and airspeed at the time of the engine failure, and the rotor RPM loss as a result of both normal pilot reaction time and the control motions required to maneuver the helicopter. The procedures described in the following paragraphs of this manual are guidelines for the specific conditions presented and cannot cover all possible flight conditions. In an actual situation these procedures must be modified by the pilot as necessary to meet the demands of the particular flight conditions and terrain below the helicopter at the time of the failure. Complete familiarity with the rotor system and helicopter autorotation characteristics through practice will ensure that the pilot will be able to make the correct decisions when faced with an actual engine failure.

WARNING

It is essential that the pilot understand that the autorotation characteristics experienced in practice with the engine at idle are NOT identical to those that will be experienced when the engine actually fails. In practice autorotations, there is both some residual engine net jet thrust as well as rotor speed support by the idling N2 turbine. In the final pitch pull prior to touchdown, with the engine at idle, there can be a significant power contribution by the engine. The rate of descent will be faster and the rotor and glide path management more critical with the engine out.

3-10. Engine Failure in Cruise Flight.

a. Collective - Down. Regain and maintain Autorotational RPM.

b. Autorotational Glide - Establish. Use collective to maintain RPM within limits.

c. Flare and Land.

d. Fuel Valve Handle - OFF. Prior to landing if possible.

e. BATT Switch - OFF. If time permits during the descent the FUEL valve and the BATT switch should be turned OFF and the "N_2/N_R" tachometer switch turned to "BATT" prior to touchdown to reduce the possibility of fire.

Engine failure in cruise flight results in the most familiar of the autorotation entries resulting in either a straight-in or turning autorotation descent and landing. In the case of straight-in and turning touchdown autorotations in training, the pilot almost always intercepts the profile in the glide phase. Airspeed and rotor speed are then adjusted to achieve the desired glide characteristics to arrive at the desired touchdown point with the rotor energy managed to allow proper termination and touchdown. Based on the height of the aircraft above the terrain, terrain available for landing, gross weight, and density altitude, the rotor RPM and airspeed can be varied to achieve the desired descent and glide characteristics.

3-11. Engine Failure on or near the Height Velocity Diagram

a. High Hover Point.

(1) Collective - FULL Down.

(2) Helicopter Attitude - 20 degrees Nose Down Immediately Accelerate immediately to minimum flare airspeed (50 KIAS).

(3) Flare and Land.

(4) Fuel Valve Handle - OFF

(5) BATT Switch - OFF.

The high hover point on the H-V Diagram has been established as that point where, following engine failure, the pilot has just enough altitude to execute a safe autorotation. This is best accomplished as follows: immediately lower the collective full down, lower the nose of the helicopter to 20 degrees nose down attitude, accelerate to 50 KIAS and immediately enter the flare to regain RPM and arrest the rate of descent prior to completing the final pitch pull and touchdown. In this autorotation the helicopter ends up intercepting the autorotation profile in the flare. Although the entry to autorotation from this condition is seldom taught, it is essential that the pilot understand exactly what control inputs are necessary to successfully maneuver the aircraft to intercept the autorotation profile. The first two actions, following engine failure, must occur almost simultaneously; first, the collective must be placed full down, to preserve rotor RPM; Second, the cyclic must be quickly displaced forward, sufficiently to place the helicopter in a 20 degree nose down attitude, to allow it to accelerate to minimum flare airspeed.

Because the entry is unusual, and possibly not familiar to the pilot, the maneuver deserves some additional discussion. First, when the cyclic is displaced forward to lower the nose of the helicopter there will be some additional incremental loss of rotor RPM due to cyclic displacement, (approximately 10 - 15 RPM more than that already lost during the normal pilot reaction time in lowering the collective). The pilot should not be alarmed by this, as long as it does not go below the minimum transient rotor speed of 300 RPM. Such an additional loss of RPM is normal and has been taken into account in developing the H-V diagram. Second, the 20 degree nose down attitude is not arbitrary but instead represents the optimum compromise between all of the factors involved. If a steeper attitude is used the rotor RPM loss will be greater, the required flare airspeed has to be higher, and the altitude loss required to achieve that higher airspeed will be greater. Additionally, the attitude changes at the bottom of the maneuver become more extreme with very little gain and much more risk of striking the ground with the tail in the flare. If the attitude is more shallow than 20 degrees nose down, then minimum flare airspeed will not be achieved prior to ground contact with the resultant that the pilot will be unable to efficiently tradeoff energy at bottom of the autorotation to arrest the rate of descent.

b. Engine Failure Between the High Hover Point and the Knee

1. Collective - FULL Down.

2. Helicopter Attitude - Nose Down As Required Accelerate immediately to, or maintain minimum flare airspeed (50 kt).

3. Flare and Land.

4. Fuel Valve Handle - OFF

5. BATT Switch - OFF

Autorotation entry between the high hover point on the H-V Diagram and the "knee" will be a variation of the technique used for the high hover point. As always, the collective must be lowered to full down immediately to preserve rotor RPM, and the pitch attitude adjusted as necessary to gain or maintain the minimum flare airspeed. At higher initial entry airspeeds there will be less nose down pitch attitude required to regain minimum flare airspeed. Where the aircraft intercepts the autorotation profile depends on how much maneuvering and altitude loss is required to achieve minimum flare airspeed. The intercept point may be anywhere from some point in the final stages of the glide to the flare.

c. Engine Failure at Low Hover (in-ground-effect)

1. Collective -Maintain.

2. Heading - Maintain.

3. Land. Time the pitch pull to cushion the landing.

4. Fuel Valve Handle - OFF

5. BATT Switch - OFF

A hovering autorotation, in-ground-effect, presents no unusual problems to the pilot. In general the collective is maintained in position after the engine failure and the aircraft allowed to settle to near ground contact before the final collective pull is accomplished. The cyclic should be used to maintain position over the ground and the pedals to maintain zero yaw rate.

If the aircraft, at the time of the engine failure, is hovering at a height above the maximum hover in-ground-effect height at the bottom of the H-V Diagram then the pilot will have to consider partially or completely lowering the collective to try to preserve as much rotor RPM as possible during the descent. He should then rapidly pull all available collective just prior to ground contact to try to cushion the landing. The oleo struts and landing gear crosstubes should absorb most of the impact forces. Depending on the aircraft height above the ground at the time of the engine failure, the pilot may elect to attempt some variation of the maneuver necessary for the high hover point to try to minimize the impact with the ground. There is no experience in this area available to advise the pilot of the correct actions to take.

NOTE

During practice "hover" autorotation, allow the N_2 to return to 64% and stabilize before advancing the throttle to the governed range. Keep torque below 30 PSI while advancing the throttle to prevent compressor surges.

d. Engine Failure on Takeoff - Below 40 KIAS

NOTE

The procedures discussed for engine failure during takeoff and the technique used to develop the H-V Diagram are based on using the airspeed-over-altitude level accelerating takeoff, where the aircraft is accelerated to 65 KIAS initial climbout airspeed at a constant skid height of 10 feet and the alternate procedure of accelerating to 48 KIAS at 10 feet then an accelerating climb to 65 KIAS at 60 feet.

1. Collective -Adjust. Lower as necessary to preserve rotor RPM, full down if possible.

2. Flare as Required and Land.

3. Fuel Valve Handle - OFF

4. BATT Switch - OFF

If the engine failure occurs during the initial takeoff run, the procedures will essentially be those for the hover in-ground-effect engine failure described above. If the collective was increased to obtain power levels greater than that for stabilized hover for the takeoff, the pilot should at least partially reduce the collective pitch to preserve as much rotor RPM as possible prior to the landing. Below 30 KIAS no flare should be attempted as the proximity of the ground will increase the likelihood of a tail rotor strike and there will be no benefit to rotor speed. The aircraft attitude should be adjusted to slightly nose up to assist in slowing the forward speed as the aircraft is cushioned onto the ground with the collective.

e. Engine Failure on Takeoff - 40 KIAS to the Knee

1. Collective -Full Down. Establish autorotation glide.

2. Flare and Land.

3. Fuel Valve Handle - OFF

4. BATT Switch - OFF

If the engine failure occurs during the final phase of the takeoff run, just prior to or after rotation to begin climb out, the pilot must immediately transition to the flare for touchdown. Collective must be immediately lowered to full down, the cyclic used to adjust the aircraft attitude from an accelerating attitude to a decelerating attitude, and the pedals adjusted to maintain the aircraft aligned with the takeoff path. Depending on the altitude of the aircraft at the engine failure, the aircraft may intercept the autorotation profile at the flare or, if near the knee, in the final portion of the glide. If takeoff power had been applied at takeoff, and prior to the engine failure, the pilot's corrective actions must be more positive to arrest rotor RPM decay and to arrest the rate of descent prior to touchdown.

f. Engine Failure - High Speed Low Altitude (10 feet and above)

1. Collective - Full Down.

2. Cyclic - Adjust. Achieve a 15 degree nose up decelerating attitude.

3. Land - level aircraft prior to touchdown.

4. Fuel Valve - OFF

5. BATT Switch - OFF

If the engine fails at high speed and low altitude above the ground the corrective action will greatly depend upon how much room there is to safely maneuver. In general, if there is at least 10 feet of skid height, the pilot can safely maintain a constant decelerating attitude until just prior to touchdown. Once again, the primary goal is to intercept the autorotation profile, and in this case it will be in the flare. Caution must be exercised to avoid striking the tail rotor.

3-12. Engine Oil - Low Pressure/High Temperature - Eng Oil Press Caution Light Illuminated

If engine oil pressure drops below the operating limit, or oil temperature increases above the operating limit or the ENG OIL PRESS caution light illuminates, accomplish a power on approach and landing immediately. If these conditions exist over terrain not suitable for landing, flight may be continued at reduced power to a favorable landing area; however, under these conditions the pilot should always be prepared for a complete engine failure.

3-13. Engine Chip Caution Light

If the ENG CHIP caution light illuminates, accomplish a power on approach and landing immediately. If these conditions exist over terrain not suitable for landing, flight may be continued at reduced power to a favorable landing area; however, under these conditions the pilot should always be prepared for a complete engine failure.

3-14. Engine Inlet Air Caution Light

If the ENG INLET AIR caution light illuminates, pull the engine Scav-Air control handle full on, reduce power and accomplish a power on approach and landing as soon as practicable. The caution light is activated by a differential pressure switch that measures the pressure drop across the swirl tube particle separator system into the lower plenum and indicates a partial blockage of the swirl tubes. Once the aircraft has been landed and shut down, investigate and correct the cause of the blockage prior to continuing flight.

3-15. MAIN DRIVE SHAFT FAILURE

A failure of the main drive shaft will be indicated by a sudden increase of engine RPM and decrease of rotor RPM, and activation of the LOW ROTOR RPM warning light and audio. A transient overspeed of N_1 and N_2 may occur but will stabilize as fuel topping limits are reached and the overspeed governor assumes control of the engine. The indications to the pilot will initially be conflicting and confusing, therefore, the initial reaction should be the same as for an engine failure. Once autorotation has been established, the pilot will be able to sort out the nature of the failure. In the event of driveshaft failure, proceed as follows:

1. Collective Pitch - Down. Establish autorotational glide.

2. Throttle - Close.

3. Land. Accomplish autorotational descent and landing.

4. Fuel Valve - OFF.

5. BATT Switch - OFF. If time permits during the descent the FUEL valve and the BATT switch should be turned OFF and the "N2/NR" tachometer switch turned to "BATT" prior to touchdown to reduce the possibility of fire.

3-16. ENGINE OVERSPEED

If an engine overspeed occurs, proceed as follows:

1. Collective Pitch - Increase to load the rotor and sustain engine RPM below the maximum operating limit.

2. Throttle - Reduce until normal operating RPM is attained.

3. Land - Perform a power on approach and landing by controlling the throttle manually.

If RPM cannot be controlled manually, proceed as outlined in the following steps:

4. Throttle - Closed when over a safe landing area.

5. Collective Pitch - Down. Establish autorotational glide.

6. Land.

7. Fuel Valve - OFF.

8. BATT Switch - OFF. If time permits during the descent the FUEL valve and the BATT switch should be turned OFF and the "N_2/N_R" tachometer switch turned to "BATT" prior to touchdown to reduce the possibility of fire.

3-17. ENGINE UNDERSPEED

1. If an engine under speed is experienced, proceed as follows:

   a. Check throttle - Full ON and GOV INCR-DECR switch setting.

   b. Lower Collective as required to see if RPM will come back and be held.

2. If RPM does not come back, then do the following:

   a. Collective Pitch - Down. Establish autorotational glide.

   b. Throttle - Closed.

   c. Land.

   d. Fuel Valve - OFF.

   e. BATT Switch - OFF. If time permits during the descent the FUEL valve and the BATT switch should be turned OFF and the "N_2/N_R" tachometer switch switch turned to "BATT" prior to touchdown to reduce the possibility of fire.

3-18. ENGINE SURGES

If surges in engine RPM are experienced proceed as follows:

1. GOV INCR/DECR Switch - Increase for maximum RPM.

2. Throttle - Reduce to 101% N_2.

3. Land Immediately. Perform a power on approach and landing without delay.

If engine surges cannot be controlled in steps 1 and 2 above, proceed as outlined in the following steps:

4. Throttle - Closed when over a safe landing area.

5. Collective Pitch - Down. Establish autorotational glide.

6. Land.

7. Fuel Valve - OFF.

8. BATT Switch - OFF. If time permits during the descent the FUEL valve and the BATT switch should be turned OFF and the "N_2/N_R" tachometer switch turned to "BATT" prior to touchdown to reduce the possibility of fire.

3-19. ENGINE COMPRESSOR STALL

Engine compressor stall (surge) is characterized by a sharp rumble or a series of loud sharp reports, severe engine vibration, and a rapid rise of TOT, depending on the severity of the surge. Maneuvers requiring rapid or maximum power applications should be avoided. Should the compressor stall continue, the following steps should be accomplished:

1. Power - Reduce.

2. Engine Anti-ice - OFF.

3. Heater - OFF.

4. Defog - OFF.

5. SCAV AIR - OFF unless in snow or ice.

If the stall still persists:

6. Land - As soon as practicable.

7. After landing perform normal shutdown.

SECTION III. ROTORS, TRANSMISSIONS, AND DRIVE SYSTEMS

3-20. TAIL ROTOR MALFUNCTIONS

Because of the many different malfunctions that can occur it is not possible to provide a solution for every emergency. The success in coping with the emergency depends on quick analysis of the condition and selection of the proper emergency procedure. The following is a discussion of some of the types of malfunctions, probable effects, and corrective actions.

a. Complete Loss Of Tail Rotor Thrust. This is a situation involving a break in the drive system, such as a severed drive shaft, sheared gears, or broken flex packs, wherein the tail rotor stops turning. This same type of situation can occur if the tail rotor controls fail with the tail rotor in a zero pitch condition, and no thrust delivered by the tail rotor. A failure of this type in forward flight will result in the nose of the helicopter turning to the right (left sideslip) and a left roll of the fuselage along the horizontal axis. Execution of an autorotative approach is the only proper emergency procedure.

(1) In powered flight the degree of sideslip and the degree of roll may be varied by changing airspeed and by varying power (throttle or pitch), but neither can be eliminated. Below an airspeed of approximately 45 knots, the sideslip may become uncontrollable, and the aircraft may begin to revolve on its vertical axis. If complete tail rotor thrust is lost during hovering flight execute a hovering autorotation.

(2) In power off flight (autorotation), following the failure, the sideslip and roll angle can be almost completely eliminated by maintaining an airspeed of 48 to 80 knots. Turns should be kept to a minimum but when required all turns should be made to the right if possible. When airspeed is decreased through approximately 20 to 30 knots, streamlining effect will be greatly reduced and the sideslip may become uncontrollable. If the landing area is a smooth hard surface, a run on landing should be made with a touchdown airspeed between 15 and 25 knots. If the surface is unprepared, start to decelerate from 75 feet altitude so that forward ground speed is at a minimum when the helicopter reaches 10 to 20 feet. Execute the touchdown with a rapid collective pull just prior to touchdown. Touchdown in a level attitude with minimum ground slide (zero if possible). Upon pitch application at touchdown the fuselage will tend to turn in the same direction as the main rotor is turning (left) due to an increase of friction in the transmission system. If the aircraft touches down with zero forward speed then hold the aircraft level and let it land with rotation. If there is forward speed, as the aircraft begins to turn on the surface in the slide follow the turn with the cyclic.

b. Fixed Pitch Setting. This is a malfunction involving a loss of control resulting in a fixed pitch setting. This can be caused by such failures as a tail rotor control cable becoming jammed or by a control cable being severed. Normally under these circumstances the directional pitch setting that is in the tail rotor at the time of the failure will, to some degree, remain for the rest of the flight. Whether the nose of the aircraft yaws to the left or right is dependent upon the amount of pedal (which is related to power) applied at the time of the failure.

(1) If the tail rotor pitch becomes fixed during an approach or other reduced power situation (right pedal applied) the nose of the aircraft will turn right when power is applied, possibly to an even greater extent than would be experienced with complete loss of tail rotor thrust, and the overall situation may be even more hazardous. The best solution may not be to autorotate. Whether a successful autorotation could be accomplished is not certain and is dependent upon the amount of pitch applied at the time of the failure. A shallow approach and running landing may be more preferable. The aircraft yaw angle can usually be adequately controlled by manipulation of the throttle just prior to touchdown and during the rollout. The pilot can easily

remember which way the nose will respond to the throttle movement by grasping the twist grip with the index finger pointed down. As the hand is rotated the index finger will indicate the direction the nose will turn, ie rotation to reduce throttle will cause the nose to turn left and vice versa. As the shallow approach is commenced the throttle should be reduced sufficiently to gain manual control of the engine and reduce the rotor RPM to the low side of the power on operating range. The approach should be made to take advantage of the full length of the runway. As the aircraft crosses over the landing threshold the airspeed should be slowly reduced to arrive at an airspeed at or above effective translational lift (ETL) just as the aircraft touches down. Just prior to touchdown the throttle should be rolled off (reduced) sufficiently to cause the nose of the aircraft to swing left and align with the runway. As the aircraft touches down and rolls out the throttle can be manipulated to control aircraft heading; "on" to yaw right, "off" to yaw left. As the aircraft slides to a halt, if it has any tendency to turn, follow the turn with the cyclic. Do not cross control or resist the turn with the cyclic.

(2) If the tail rotor becomes fixed during a takeoff or other increased power situation (left pedal applied) the nose of the aircraft will turn left when power is reduced (as in leveling off with cruise power). Under these circumstances an autorotative landing must not be attempted. It is usually possible to continue powered flight to an airfield and to perform a powered running landing. Depending upon the power setting at the time of the failure, the sideslip angle will probably be almost completely eliminated when power is applied for touchdown. When the approach is commenced, the engine N2 RPM should be manually decreased to 100%. The sideslip angle will increase as will the requirement for a considerable amount of right cyclic, however this will be corrected when power is applied to terminate at touchdown. Due to this sideslip on the approach, a higher than normal approach speed may be beneficial. In this instance powered landing may be the best solution and it is unlikely that an autorotation can be accomplished at all.

(3) If the tail rotor becomes fixed during normal cruise power setting, the helicopter reaction should not be as pronounced as in the previously described situations and, at speeds from 40 to 80 knots, the tail should streamline with very little sideslip or fuselage roll angle. In this instance, autorotation may aggravate the situation because a reduction of power (torque) may then result in a right sideslip (left yaw). It must be considered, however, that an increase in power at touch down will result in a left sideslip (right yaw) if a powered approach is used. The first thing the pilot must do in this situation is to determine what power setting results in balanced flight. That power (torque) setting then can be related to the power required for initial hover. If the cruise power for balanced flight is more than that required for the initial hover then the pilot will most likely be able to return to a hover. If the power is less than the initial hover power then possibly a running landing may be the best solution with a very low touchdown speed and throttle manipulation similar to that described in the fixed right pedal failure section of this chapter.

c. Complete Loss of Tail Rotor or Components. The seriousness of this situation is dependent upon the amount of weight lost. Any loss of this nature will result in a forward center of gravity shift. Immediate autorotation may be the only solution of possible value.

3-21. MAIN XMSN CHIP OR TAIL CHIP CAUTION LIGHT ILLUMINATION

If the MAIN XMSN CHIP or the TAIL CHIP caution lights illuminate accomplish a power on approach and landing as soon as practicable.

3-22. DRIVE BEARING HOT CAUTION LIGHT ILLUMINATION

If the DRIVE BRG HOT caution light illuminates accomplish a power on approach and landing immediately. If this condition occurs over terrain not suitable for a landing, flight may be continued at reduced power to a favorable landing area; however, under these conditions the pilot should be prepared for a partial power loss or drive system failure at any time.

3-23. MAIN XMSN HOT CAUTION LIGHT ILLUMINATION

a. If the MAIN XMSN HOT and the MAIN XMSN CHIP caution lights are both on, or the MAIN XMSN HOT caution light illuminates without apparent cause, such as prolonged hovering at high ambient temperature, verify the temperature indication by referring to the main transmission temperature gauge. If the high temperature indication appears to be valid, perform a power on approach and landing immediately.

b. If the MAIN XMSN HOT caution light illuminates after prolonged hovering in high ambient temperatures, proceed as follows:

(1) Verify the indication by referring to the main transmission temperature gauge.

(2) If at a hover, proceed into forward flight at 60 KIAS. The temperature should stabilize and begin decreasing within a few minutes.

(3) If, after 10 minutes of forward flight, the temperature doesn't decrease sufficiently to extinguish the caution light (below 100°C), land immediately.

3-23.1. MAIN ROTOR GEARBOX PRESSURE CAUTION LIGHT ILLUMINATION

NOTE

This paragraph (3-23.1) does not apply to aircraft not equipped with the filtration/cooling system on the main rotor transmission.

a. If the MRGB PRESS caution light illuminates, land as soon as practical.

(1) After landing and shutdown, inspect the main rotor transmission filtration/cooling system for oil leaks and broken oil lines. Inspect the main rotor transmission for proper oil level.

(2) If no oil leaks or broken oil lines are found and the main rotor transmission has the proper oil level, the fault is either a pump failure or a pressure switch failure. Open the MRGB PUMP circuit breaker and continue operation of the aircraft to the final destination.

(3) After arrival at the final destination, repair the filtration/cooling system before continuing operation of the aircraft.

b. If the MRGB PRESS and the MAIN XMSN HOT caution lights are illuminated, verify the temperature indication by referring to the main transmission temperature gauge. If the high temperature indication appears to be valid, perform a power on approach and landing immediately.

3-23.2. ROTOR RPM WARNING LIGHT ILLUMINATION

If the ROTOR RPM warning light illuminates, immediately lower the collective to increase the RPM as required to return the RPM to the normal operating range. The only exception to this requirement is when the light illuminates because the RPM is low during an autorotational flare immediately prior to touchdown. After lowering the collective, continue to monitor the tachometer and control the RPM by manipulating the collective.

SECTION IV. FIRE

3-24. GENERAL.

The safety of the occupants of the aircraft is the primary consideration when a fire occurs. On the ground it is essential that the engine be shut down, crew and passengers evacuated, and fire fighting efforts be commenced with the hand held extinguisher at the discretion of the pilot. If time permits, a "MAYDAY" radio call should be made before the electrical power is shut off to expedite assistance from airfield fire fighting equipment and personnel. If the helicopter is airborne when a fire occurs, the most important single action that can be taken by the pilot is to land the helicopter immediately.

WARNING

Some hand held fire extinguishers (e.g., Halon) contain toxic fumes. Use these hand held fire extinguishers only in well ventilated areas because the toxic fumes of the extinguishing agent may cause injury.

3-25. ENGINE COMPARTMENT FIRE - FLIGHT

When the FIRE warning light illuminates it is essential that the following immediate action steps be taken, altitude and time permitting:

1. Collective pitch - Down enter autorotation.

2. Throttle - Idle

3. Fire Warning Light - Note. If FIRE warning light extinguishes within 10-15 seconds, resume powered flight at a reduced power level and land as soon as practicable, as this is symptomatic of a cracked combustor case.

If FIRE warning light is still illuminated proceed as follows:

4. Throttle - close

5. Land Accomplish autorotating descent and landing.

6. Fuel Valve - OFF

7. BATTery and GENerator switches - OFF. If time permits during the descent the FUEL valve and the BATT switch should be turned OFF and the "N_2/N_R" tachometer switch turned to "BATT" prior to touchdown.

8. Clear the helicopter of all passengers and crew immediately and if practical fight the fire with the hand held cockpit fire extinguisher.

3-26. HOT START - EMERGENCY SHUTDOWN

The following procedure is applicable during engine starting if flames are emitted from the exhausts, TOT limits are exceeded, or it becomes apparent that TOT limits will be exceeded.

1. Throttle - Close The throttle must be closed immediately.

2. Starter switch - Continue to press The starter switch must be held until the TOT is in the normal operating range.

3. Fuel Valve - OFF.

3-27. ENGINE FIRE - GROUND

1. Throttle - Close

2. Fuel Valve - OFF

3. BATT Switch - OFF

4. Clear the helicopter of all passengers and crew immediately. If practical, fight the fire with the hand held cock-pit fire extinguisher.

3-28. FUSELAGE FIRE ON THE GROUND

If fire is observed in any part of the helicopter during ground operations proceed as follows:

1. Throttle - Closed

2. Fuel Valve- OFF

3. BATT Switch - OFF

4. Clear the helicopter of all passengers and crew immediately and if practical fight fire with cockpit fire extinguisher.

3-29. FUSELAGE FIRE - FLIGHT

If fire is observed in any part of the helicopter in flight, proceed as follows:

1. Land Immediately. Perform a power-on approach and landing without delay.

2. Throttle - Close as soon as the helicopter is on the ground.

3. Fuel Valve - OFF

4. BATT Switch - OFF

5. Clear the helicopter of all passengers and crew immediately and if practical fight fire with cockpit fire extinguisher.

3-30. ELECTRICAL FIRE - FLIGHT

In the event of electrical fire or suspected electrical fire in flight, including avionics, battery, and other electrical components, proceed as follows:

1. GENerator Switch - OFF

2. BATT Switch - OFF

3. N2/NR Switch - BATT BUS

4. Land Immediately. Perform a power on approach and landing without delay.

5. Engine Shutdown After landing complete as follows:

a. Throttle - Closed

b. Fuel Valve - OFF

c. Clear the helicopter of passengers and crew immediately.

3-31. ELECTRICAL FIRE - FLIGHT (WHEN LANDING CANNOT BE MADE IMMEDIATELY)

In the event a landing cannot be made immediately and flight must be continued, the defective circuits may be identified and isolated as follows:

1. Complete steps 1 thru 3 of paragraph 3-30 above.

2. Circuit breakers - Out

As each of the following steps is accomplished, check for indications of the source of the fire.

3. GENerator Switch - GEN

4. BATT Switch - BATT

5. Circuit Breakers - In one at a time in the priority required. Monitor the ammeter. When the malfunctioning circuit is identified, pull the applicable circuit breaker out and leave it out for the duration of the flight. A malfunctioning circuit can be identified by recurrence of the smoke or fire, and possibly a sharp increase in the electrical load as the circuit breaker of the malfunctioning circuit is pushed in.

3-32. ELECTRICAL FIRE - GROUND

In the event of electrical fire or suspected electrical fire during ground operations proceed as follows:

1. Throttle - Close

2. Fuel Valve - OFF

3. BATTery Switch - OFF

4. Clear the helicopter of passengers and crew immediately.

3-33. SMOKE AND FUME ELIMINATION

Smoke and/or toxic fumes entering the cockpit and cabin can be exhausted as follows:

1. Vents - Open

2. Defog, Heater, and Fresh Air Valves - ON

NOTE

If smoke is coming from the defog, heater, or fresh air system, turn them off.

CAUTION

Do not jettison doors.

3.34. RESERVED

SECTION V. FUEL SYSTEM

3-35. FUEL FILTER CAUTION LIGHT ILLUMINATION

If the FUEL FILTER caution light illuminates, perform a power on approach and land as soon as practicable.

3-36. FUEL LOW CAUTION LIGHT ILLUMINATION

When the FUEL LOW caution light illuminates, there are approximately five gallons of fuel remaining. At normal power settings this will last approximately ten minutes. Note the time when the light illuminates and plan a landing prior to fuel exhaustion. Avoid excessive maneuvering which might cause fuel to slosh and unport the fuel tank outlet.

3-37 LEAD ACID BATTERY

1. "Shorting" malfunction of the lead-acid battery will cause high amperage readings. If excessively high amperage is noted with no apparent cause:

a. MAIN GEN Switch – Off.

2. Then, if the electrical equipment stops operating and/or the voltmeter indicates very low voltage (e.g. below 20 volts):

a. BATT Switch – Off.

b. AVIONICS Switch – Off.

c. MAIN GEN Switch – On. Monitor ammeter.

3. Then, if the electrical systems operate normally and the amperage is appropriate:

a. AVIONICS Switch – On.

b. LAND – as soon as practicable. Make an entry in the aircraft log book.

3-37.1 NICAD BATTERY

1. BATTERY TEMP caution light illuminated:

a. Battery Switch – OFF and leave OFF even if the BATTERY TEMP light goes out.

b. LAND – As soon as practicable and have maintenance personnel investigate the cause. Make an entry in the aircraft log book.

2. BATTERY HOT warning light illuminated:

a. Battery Switch – OFF.

b. LAND – Immediately. Make an entry in the aircraft log book.

3-38. GENERATOR MALFUNCTION – Zero Output

A malfunction of the generator will be indicated by a zero indication on the ammeter and a DC GEN caution light illuminating. The voltmeter will indicate battery voltage. An attempt may be made to put the generator back on line by accomplishing the following:

1. GEN FIELD circuit breaker – IN.

2. GEN Switch – OFF then GEN.

3. If the main generator does not come back on line or if it goes off the line again, GEN Switch OFF. Turn off all unnecessary electrical equipment and land as soon as practicable.

3-38.1. MAIN BUS FAILURE

In the event of a complete main electrical bus failure, the "N_2/N_R" tachometer indications can be restored by switching the "N_2/N_R" switch from "Main" to "BATT". All other systems and indicators which are absolutely necessary for flight in visual meteorological conditions will continue to function without electrical power. Most of the other aircraft systems, however, such as warning, navigation, and communication systems will be inoperative. Land as soon as practicable.

SECTION VII. DITCHING

NOTE

The following information is presented to provide the pilot with the best information possible in the event that a forced landing must be made in the water. This helicopter is not certified for ditching without floats and this section should not be construed as implying such certification.

3-39. GENERAL.

a. Ditching with Power. If ditching is unavoidable without other recourse, proceed as follows:

1. Descend to low hovering altitude over water.

2. Unlatch both doors.

3. Exit passengers.

4. Hover clear of passengers.

5. Turn off battery and generator.

6. Close throttle and complete hovering autorotation.

7. As collective reaches full up position and helicopter settles into water, apply full right lateral cyclic.

8. Exit helicopter when rotor stops.

WARNING

Clear helicopter as quickly as possible.

b. Ditching without Power. If engine failure occurs over water, accomplish engine failure emergency procedure and proceed as follows:

1. Unlatch doors.

2. Land. Complete normal autorotational landing in water.

3. As collective reaches full up position and helicopter settles in water, apply full lateral cyclic in direction helicopter tends to roll.

4. Pilot and passengers exit helicopter when main rotor stops.

WARNING

Clear helicopter as quickly as possible.

SECTION VIII. FLIGHT CONTROL MALFUNCTIONS

3-40. LAMIFLEX BEARING FAILURES

NOTE

This paragraph (3-40) does not apply to aircraft equipped with tension-torsion strap (T-T Strap) main rotor blade retention assemblies.

A lamiflex bearing failure will cause a rough ride. Initially, this may be only a minor distraction, but in some cases, it can progress quickly to the point where the bearing physically comes apart. In this case, control of one blade will be stiff, the main rotor will be severely out of balance, and aircraft control may be in jeopardy. The following are indications of a lamiflex bearing failure as it progresses.

1. A significant worsening of the ride quality from one flight to the next or from one day to the next for no apparent reason.

2. The aircraft cannot be trimmed at a hover or runs out of trim at maximum forward flight speed when previously there was no problem.

3. The collective suddenly ratchets when moved up and down when previously it had been smooth or the collective suddenly feels heavy

4. The cyclic suddenly wobbles or moves in a circular motion when previously it had been smooth.

5. The cyclic suddenly starts "chucking," (moving sharply in a left rear to right forward direction in about a 3/4" amplitude with a very crisp motion) especially at high power or high airspeed.

WARNING

This last indication where the cyclic starts sharply moving may be followed within a few minutes by a total failure of the bearing.

<u>**Emergency Procedures - Impending Lamiflex Bearing Failure**</u>

The following are the procedures to be used in dealing with lamiflex failures. Refer to the preceding paragraph for the description of the failure symptoms.

1. Moderate - Slight worsening in ride or not able to trim:

a. <u>**LAND** - As soon as practicable</u>. Have all three bearings inspected before the next flight.

2. Serious - Ride continues to get worse or the cyclic or collective start showing symptoms:

a. <u>**LAND** - Immediately.</u> Have all three bearings inspected before further flight.

<u>**Emergency Procedures - Total Lamiflex Bearing Failure**</u>

The following are the procedures to be used in dealing with total lamiflex bearing failure.

1. <u>Maintain control of the aircraft</u>.

2. <u>Collective - Lower slowly</u>. Commence an 800-900 ft/min descent.

WARNING

Do <u>NOT</u> autorotate. Aircraft control at the termination of an autorotation may be questionable with a totally failed lamiflex.

3. <u>Airspeed - Reduce</u> to 50-60 MPH.

4. <u>Rotor RPM - Reduce</u> to minimum power on RPM.

5. <u>Maneuvering - Minimize</u>.

6. <u>Land</u> - Perform a running landing. Touch down at or above Effective Translational Lift (ETL), approximately 20 knots if terrain permits.

WARNING

It may not be possible to control the aircraft in a hover.

7. Shutdown - Complete.

3-41. CYCLIC CONTROL VIBRATION ABSORBER BEAM FAILURE

NOTE

This paragraph (3-41) does not apply to aircraft not equipped with cyclic control vibration absorber assemblies.

Failure of a cyclic control vibration absorber beam will result in a sudden increase in the 3/Rev vibration level felt in the cyclic control stick. In the event of a sudden increase of 3/Rev vibration in the cyclic controls, land as soon as practicable, shutdown the aircraft, and inspect the vibration absorber beams. Before continuation of flight, the failed portion of the beam and lanyard shall be removed from the aircraft. Continued operation of the aircraft after beam failure is approved; however, the cyclic control vibration levels will be significantly higher and the vibration absorber assembly should be repaired as soon as possible.

3-42. CYCLIC TRIM FAILURE

Failure of the cyclic trim control system will result in either inoperative trim or a trim runaway in one of the four primary directions (forward, aft, left or right). If the trim circuit breaker trips, it should be left out for the remainder of the flight. Depending upon the failure mode and the flight condition at the time of failure, the cyclic forces may be relatively light or they may be excessive. The pilot should evaluate the situation and determine if a precautionary landing is indicated or if the flight should be completed as planned. The pilot should be aware that the cyclic forces will change between cruise flight and approach and landing.

If the trim stops operating when the switch is engaged, the trim does not stop when the switch is released, or if the circuit breaker trips, the operator should:

1. Immediately stop using the trim and pull the TRIM circuit breaker to deactivate the circuit. Leave the circuit breaker out for the remainder of the flight.

2. If the pilot determines the flight can be continued safely, without use of the trim, flight may be continued to the next destination.

3. If the pilot has any safety concerns, a landing should be made as soon as practical.

a. If there is a significant reduction in the longitudinal control, the pilot should plan a landing at a shallow approach to an area where a run-on landing can be made.

b. If there is a significant reduction in the lateral cyclic control, it may be difficult or impossible to make turns to the right.

(1) The pilot should plan a landing to an area where there is ample room to maneuver. The aircraft will fly in a left crab, and maintaining a straight course may be difficult.

(2) Perform an approach to a low hover; forward speed can be stopped, but there may be some sideward drift.

(3) Once forward speed is reduced in a low hover, the pilot can roll off the throttle and align the aircraft with the direction of motion using the pedals prior to touching down.

(4) If the pilot is having difficulty maintaining the approach course, the pilot should consider making a 360° turn to the left to line up on the final approach again.

(5) Directional control is easier to maintain at airspeeds above 60 knots, but the pilot must plan to reduce forward speed prior to touchdown.

4. Ground the aircraft at the end of the flight. The aircraft should be grounded until the problem is resolved by a maintenance technician.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 4

PERFORMANCE DATA

SECTION I. INTRODUCTION

4-1. Purpose The purpose of this chapter is to provide the best available data for the 480 helicopter. Regular use of this information will enable you to obtain maximum safe utilization from your aircraft. Although maximum performance is not always required, regular use of this chapter is recommended for the following reasons:

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

b. Situations requiring maximum performance will be readily recognized.

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

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

NOTE

The information provided in this chapter is primarily intended for flight planning and is most useful when planning operations in unfamiliar areas or at extreme conditions.

4-2. General The data presented covers the maximum range of conditions and performance that can reasonably be expected. In each area of performance, the effects of altitude, temperature, gross weight, and other parameters relating to that phase of flight are presented. In addition to the presented data, your judgement and experience will be necessary to accurately obtain 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. All performance data presented are within the applicable limits of the aircraft.

4-3. Limits Applicable limits are shown on the charts as darker lines. Performance generally deteriorates rapidly beyond limits. If limits are exceeded, minimize the amount and time. Enter the maximum value and time above limits in the aircraft log book so proper maintenance action can be taken.

4-4. Use of Charts The first page of each section describes the chart(s) and explains the useage. The primary use of each chart is given in an example and a line with arrows is provided to help you follow the route through the chart. The use of a straight edge (ruler, etc.) and a hard fine point pencil is recommended to avoid cumulative errors. Other uses of each chart are explained in the text accompanying each set of performance charts.

4-5. Specific Conditions The data are presented only for specific conditions listed under the title for each chart. Variables for which data are not presented, but which may effect that phase of performance, are discussed in the text. Where data are available or reasonable estimates can be made, the amount that each variable effects the performance will be given.

4-6. General Conditions In addition to the specific conditions, the following general conditions are applicable to the performance data:

a. Rigging. All airframe and engine controls are assumed to be rigged within allowable tolerances.

b. Pilot Technique. Normal pilot technique is assumed. Control movements should be smooth and continuous.

c. Aircraft Variation. Variations in performance between individual aircraft are known to exist, however, they are considered to be small and cannot be individually accounted for.

d. Instrument Variation. The data shown in the performance charts do not account for instrument inaccuracies or malfunctions. The data presumes that all instruments, indicators, and transducers are maintained in proper working condition and are properly maintained in calibration.

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

4.8. Reserved

SECTION II. PERFORMANCE PLANNING

4-9. Purpose This section contains a performance planning card, a temperature conversion chart, and information needed for use of the performance planning card.

4-10. Performance Planning Card The performance planning card is presented in figure 4-1 and is provided to assist you in recording data applicable to the flight. This card may be reproduced as necessary.

4-11. Performance Planning Sequence The following sequence is provided to aid in preparing the performance planning card.

a. Obtain departure point pressure altitude by setting 29.92 in hg (1013 mb) at the altimeter barometric pressure scale and reading pressure altitude from outer scale pointers. Record the value in the space provided in the 'Departure' section. Estimate pressure altitudes for climb, cruise, and arrival by adding the altitude increase above departure elevation, (if destination is below departure elevation, subtract difference in elevation). Record pressure altitudes in space provided in the climb, cruise, and arrival sections.

b. Outside Air Temperatures. Obtain the local outside air temperature and record it in the space provided in the departure section. Estimate the OAT for the climb, cruise, and arrival by using the temperatures from the winds aloft and destination forecasts or by subtracting 2 degrees C for each 1000 feet altitude increase above the departure point, (if the destination is below the departure point, add 2 degrees C for each 1000 feet difference in elevation). Record the temperatures in the spaces provided in the climb, cruise, and arrival section.

NOTE

See figure 4-2 for temperature conversion from degrees F to C or vice versa and figure 4-3 - Density Altitude Chart.

c. Departure.

(1). Calculate and record the departure gross weight and CG. Refer to Chapter 6 and cross reference maximum allowable takeoff/landing gross wt. See figure 4-7.

(2). Determine and record torque available. See figure 4-6.

(3). Determine the torque required to hover IGE. See Figure 4-9.

(4). Determine if takeoff to hover can be made by comparing the torque required for desired skid height with maximum torque available. For takeoff, torque available must be greater than the torque required.

(5). Determine and record obstacle height.

(6). Determine and record distance over 50 foot obstacle. (Figure 4-8)

d. Climb.

(1). Determine and record speed for maximum rate of climb, CAS, reference figure 4-13, convert to TAS for density altitude. Determine torque required to cruise at this airspeed, reference figure 4-11.1 through 4-11.3.

NOTE

Virtually all flight computers contain a CAS to TAS conversion function. In the absence of such a computer, CAS can be converted to TAS by dividing CAS by the square root of the density ratio, $\sqrt{\sigma}$, as listed in Figure 4-3. TAS can be converted to CAS by multiplying TAS by $\sqrt{\sigma}$.

(2). Record maximum torque available and maximum fuel flow. Reference figure 4-6. (Maximum fuel flow can be determined from Figures 4-11.1 through 4-11.3 as follows: Enter

PERFORMANCE PLANNING

DEPARTURE

PRESS. ALT ____________ FT OAT ______________ °C GW _____________________ LB

MAX TORQUE AVAILABLE ________________ PSI CG _____________________ IN

TORQUE REQUIRED TO HOVER _____________ PSI HOVER HEIGHT ____________ FT

OBSTACLE CLEARANCE

OBSTACLE HEIGHT ____________ FT DISTANCE _______________ FT

CLIMBOUT IAS _______________ KNOTS

CLIMB

PRESS. ALT ____________ FT OAT _____________ °C GW _____________________ LB

MAX R/C IAS ___________ KNOTS MAX TORQUE AVAILABLE _______________ PSIG

LEVEL FLIGHT TORQUE AT R/C IAS __________ PSI

CHANGE IN TORQUE FOR CLIMB _____ PSI (MAX TORQUE AVAIL - LEVEL FLT TORQUE)

RATE OF CLIMB _________ FT/MIN FUEL FLOW _____________ LB/HR

ESTIMATED TIME TO CLIMB _______________________

CRUISE

PRESS. ALT _____________ FT OAT _____________ °C GW _____________________ LB

CRUISE SPEED. TAS _______ KNOTS CRUISE SPEED. IAS ________________ KNOTS

(CRUISE SPEED MUST NOT EXCEED V_{NE})

CRUISE TORQUE __________ PSI CRUISE FUEL FLOW _________________ LB/HR

ESTIMATED TIME ENROUTE ____________________________

ARRIVAL

PRESS. ALT _____________ FT OAT ______________ °C GW _____________________ LB

MAX TORQUE AVAILABLE _______________ PSI HOVER HEIGHT ____________ FT

TORQUE REQUIRED TO HOVER ___________ PSI APPROACH SPEED IAS __________ KNOTS

FIGURE 4-1. PERFORMANCE PLANNING CARD

EXAMPLE

WANTED

TEMPERATURE IN DEGREES CELSIUS

KNOWN

TEMPERATURE -+32 F.

METHOD

ENTER TEMPERATURE HERE

MOVE RIGHT TO DIAGONAL LINE

MOVE DOWN TO DEGREES CELSIUS SCALE

READ TEMPERATURE 0 C.

REVERSE THIS PROCEDURE TO CONVERT FROM CELSIUS TO FAHRENHEIT

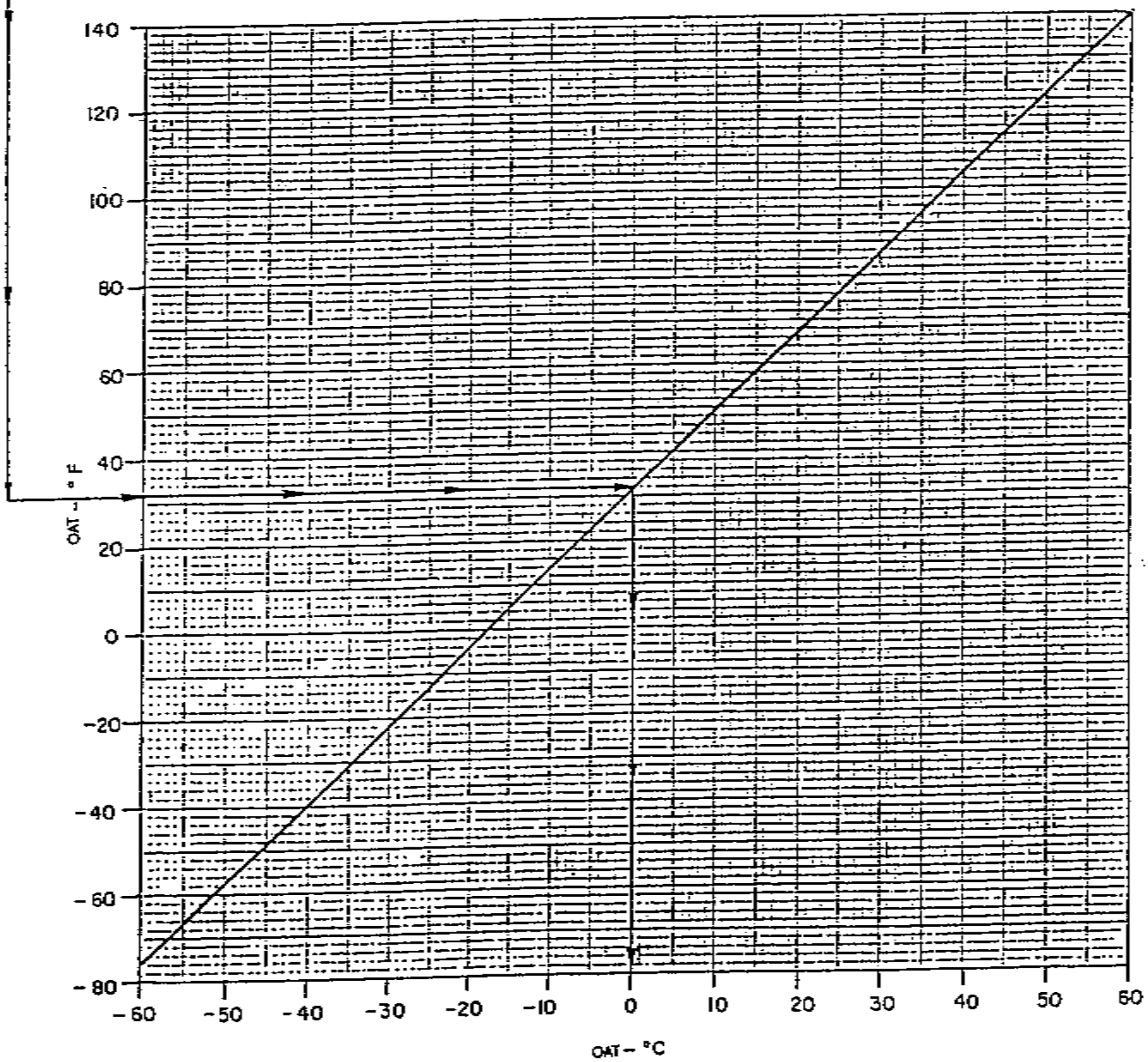


FIGURE 4-2. TEMPERATURE CONVERSION CHART

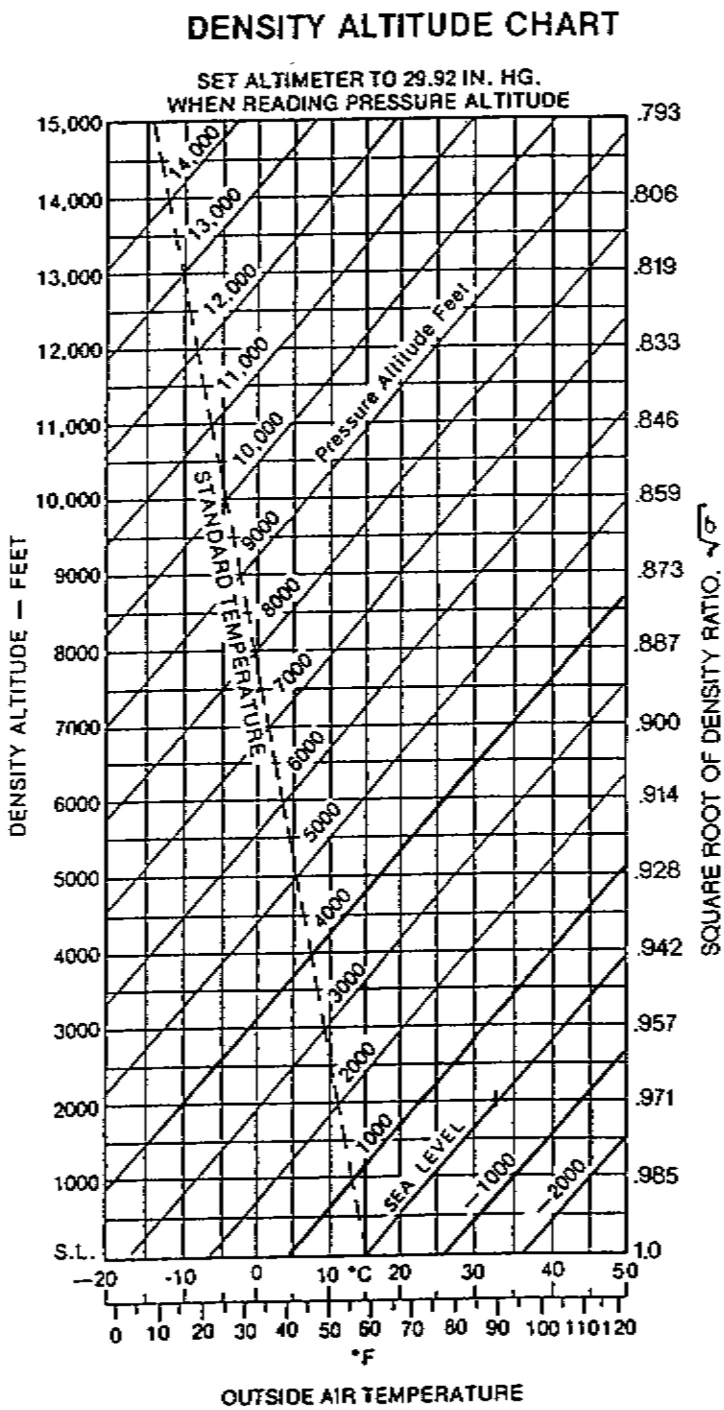


FIGURE 4-3 DENSITY ALTITUDE CHART

the "Calibrated Torque vs Airspeed" curve at the maximum torque and determine the corresponding airspeed. Then read the fuel flow at this airspeed from the "Airspeed vs Fuel Flow" curve.)

(3). Subtract level flight torque required from maximum torque available to obtain excess torque for climb. Record this value.

(4). Determine rate of climb from figure 4-14.

e. Cruise

(1). Select and record cruise speed (TAS).

NOTE

Cruise speed must not exceed V_{NE} for the cruise altitude and temperature and the take-off gross weight and center of gravity. See Chapter 1.

(2). Calculate and record gross weight at beginning of cruise segment or average weight during cruise segment.

(3). From Figures 4-11.1 through 4-11.3 determine and record cruise torque and cruise fuel flow.

f. Arrival

(1). Calculate and record gross weight and maximum allowable gross wt. See figure 4-7.

(2). Select and record approach speed (TAS).

(3). Using the method described for departure in steps c (2), (3), and (4) above, determine whether a hovering approach to landing can be accomplished. Torque available for landing must exceed torque required. See figure 4-9.

NOTE

Performance information obtained may make it necessary to alter the gross weight, airspeed, altitude, or other variables in order to safely operate the aircraft. If any of these variables are changed on one chart, corresponding changes will be necessary on all other charts where that information is used.

4-12. Effect of Engine Anti-Ice on Power Available Engine anti-ice results in higher TOT, N1 speed and fuel flow to achieve the same torque setting. Because the engine is derated, normally torque will be the limiting consideration. However, in some conditions, TOT or N1 may approach operational limits thus limiting the power available. Table 4-1 lists the approximate effect of engine anti-ice on engine performance. This table is based on sea level standard day conditions.

TYPE OF OPERATION	APPROX. EFFECT ON PERFORMANCE (@ power levels above 78.5% N1)
Constant TOT (810) (Takeoff power)	37 SHP decrease, 1.82% N1 decrease
Constant N1 of 101%	13 SHP decrease, 38 deg C TOT increase
Constant SHP and constant collective	0.88% N1 increase, 56 deg C TOT increase and up to 20% increase in fuel consumption

TABLE 4-1. EFFECT OF ENGINE ANTI-ICE ON POWER AVAILABLE

SECTION III. AIRSPEED CALIBRATION

4-13. Description Airspeed calibration charts are provided for two different pitot tube locations. Fig 4-4 presents the airspeed correction for the standard "chin mounted" pitot tube. Fig 4-5 presents the airspeed correction for the optional "nose mounted" pitot tube. The airspeed calibration charts show the correction to be added to the indicated cockpit airspeed to obtain calibration airspeed. The charts show corrected curves for descent/autorotation, level flight and climb.

4-14. Use of the Charts The primary use of the charts is indicated by the examples. In general it is not essential to know the correction to the indicated airspeed unless the pilot desires to achieve very precise performance from the helicopter. The corrections are sufficiently small that one or two knot variation between the indicated airspeed and the actual calibrated airspeed will have an insignificant effect on the aircraft performance. To determine the correction to be added, the pilot must know the airspeed of interest and the maneuver to be flown. By entering the chart from the bottom, at the airspeed, and moving vertically up to the curve for the intended maneuver, then left to the scale on the left side of the chart, the correction to be added to the cockpit indicated airspeed can be obtained.

4-15. Alternate Static Source. The aircraft may be provided with an optional alternate static source which allows the pilot to use the interior of the cabin as a static reference. Due to inherent inaccuracies, this system should only be used when necessary, for example if icing conditions are encountered and cannot be avoided. With the cabin windows closed, the airspeed indicator will read approximately 5 knots high at slow airspeeds (40 KIAS) and 10 knots high at high airspeeds (115 KIAS). The altimeter error will range from almost zero at low airspeeds to 100 feet high at high airspeeds. (See Table 4-2.) With the windows open, the errors range from approximately 8 knots high and 50 feet high at low airspeeds to 15 knots high and 150 feet high at high airspeeds. Heater and defroster operation does not affect these errors. Except as specifically mentioned, all data in this manual is based on the standard static system.

ALTERNATE STATIC SOURCE ALTIMETER CORRECTION		
INDICATED AIRSPEED (KNOTS)	ADD TO ALTIMETER READING	
	WINDOWS CLOSED (FEET)	WINDOWS OPEN (FEET)
40	+5	0
50	+5	-15
60	-10	-35
70	-25	-55
80	-40	-75
90	-60	-95
100	-75	-115
110	-95	-140
120	-115	-170

TABLE 4-2. ALTERNATE STATIC SOURCE CORRECTION

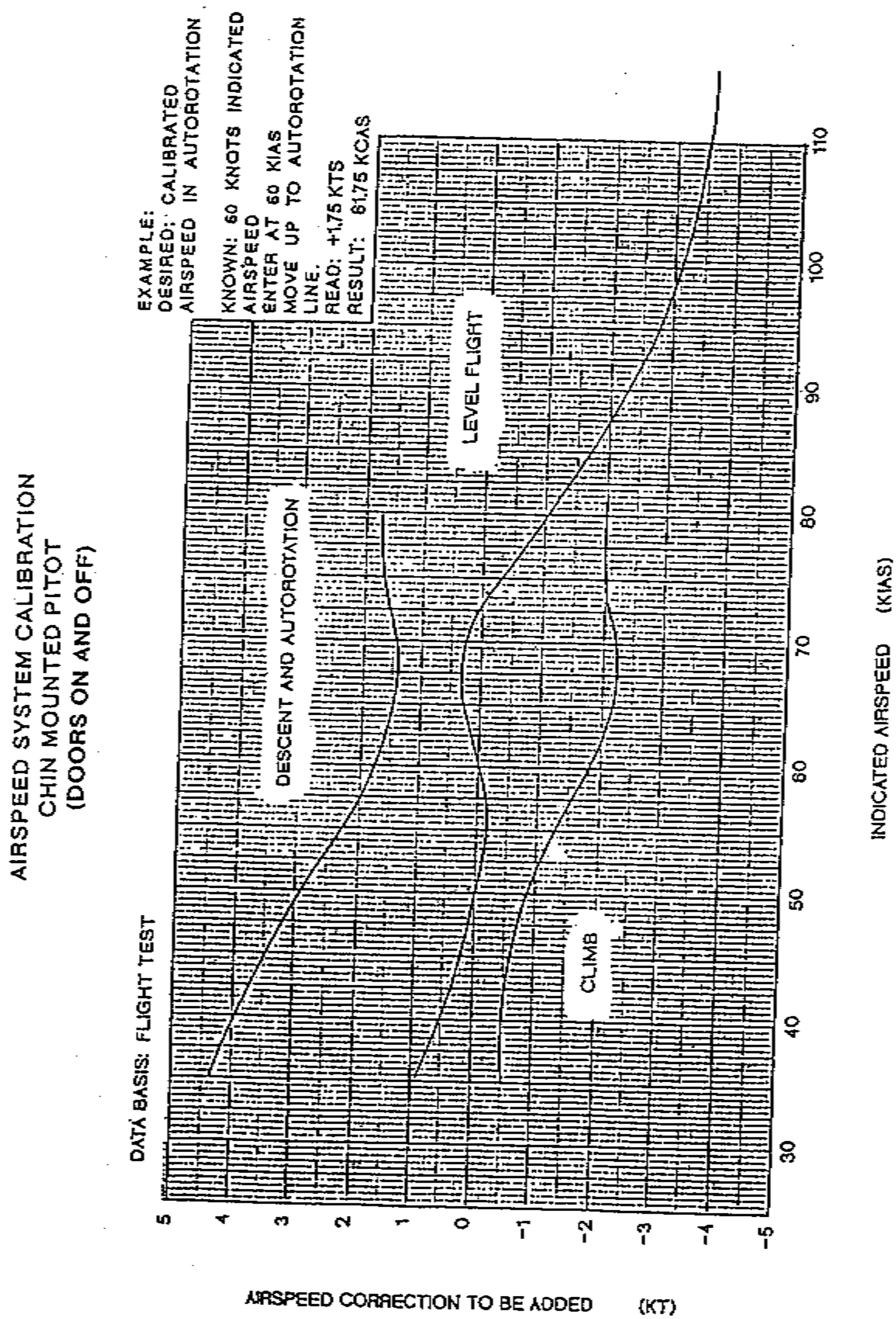


FIGURE 4-4. AIRSPEED CALIBRATION

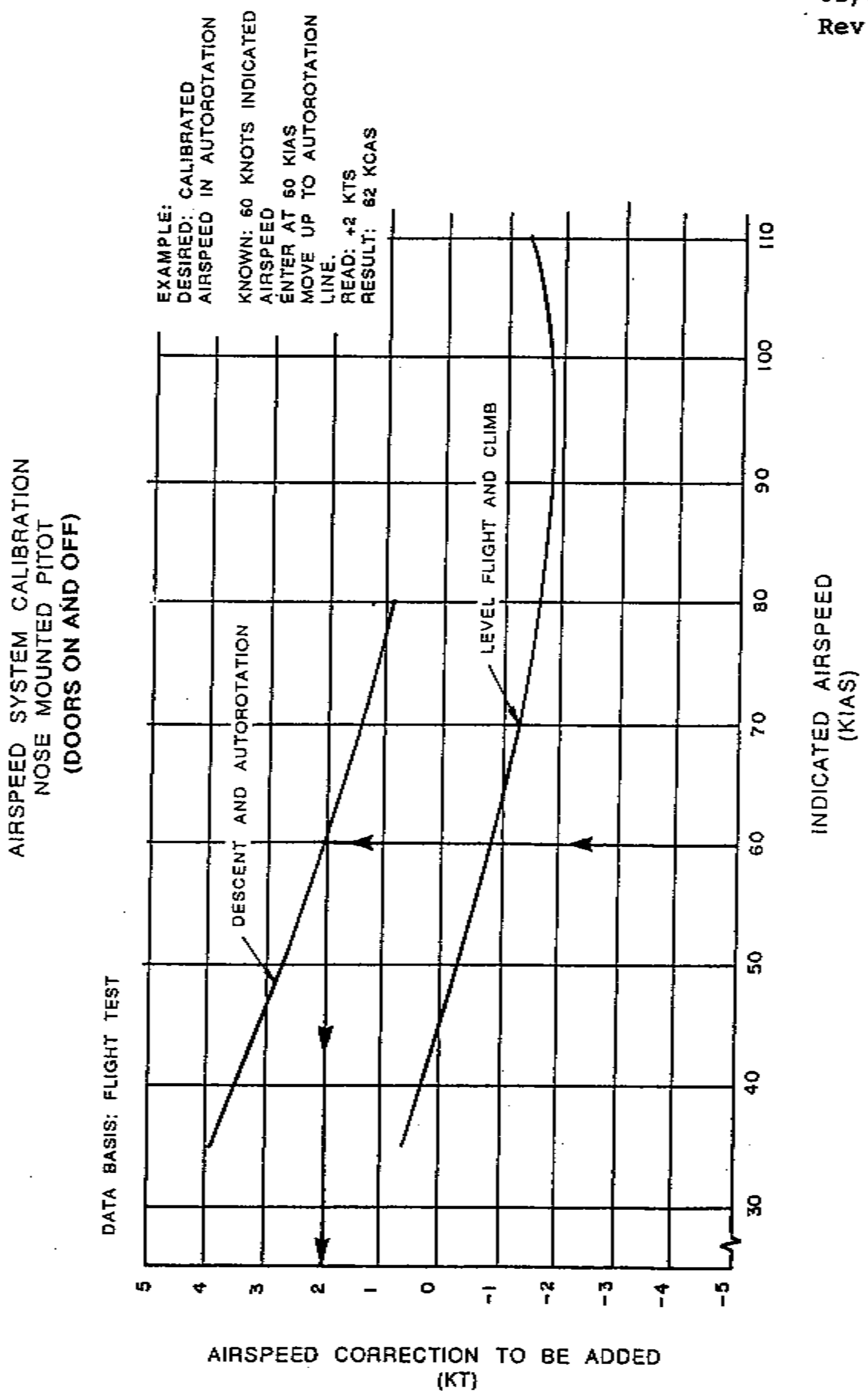


FIGURE 4-5. AIRSPEED CALIBRATION

SECTION IV. TORQUE AVAILABLE

4-16. Description The torque available chart shows the effects of altitude and temperature on engine power available.

4-17. Chart Uses Figure 4-6 shows the maximum torque available as limited by either the transmission or the engine. The primary use of the chart is to provide the pilot information on the maximum power available either as a function of the helicopter limits or the flight conditions. Since both pressure altitude and outside air temperature effect engine power it is necessary that the pilot enter the chart with both values. By entering the chart at the left side at the known pressure altitude and moving right to the known OAT, then straight down to the bottom, available torque is obtained.

CAUTION

The engine power output can exceed the transmission structural limit (67 PSI) under certain conditions. Where the torque obtained from this chart is less than the transmission limit, the engine TOT will be at the 810 degrees C (1490° F) limit at the torque obtained. It is the responsibility of the pilot to monitor and observe both the torque (transmission) and TOT (engine) limits during all operations where maximum power is required.

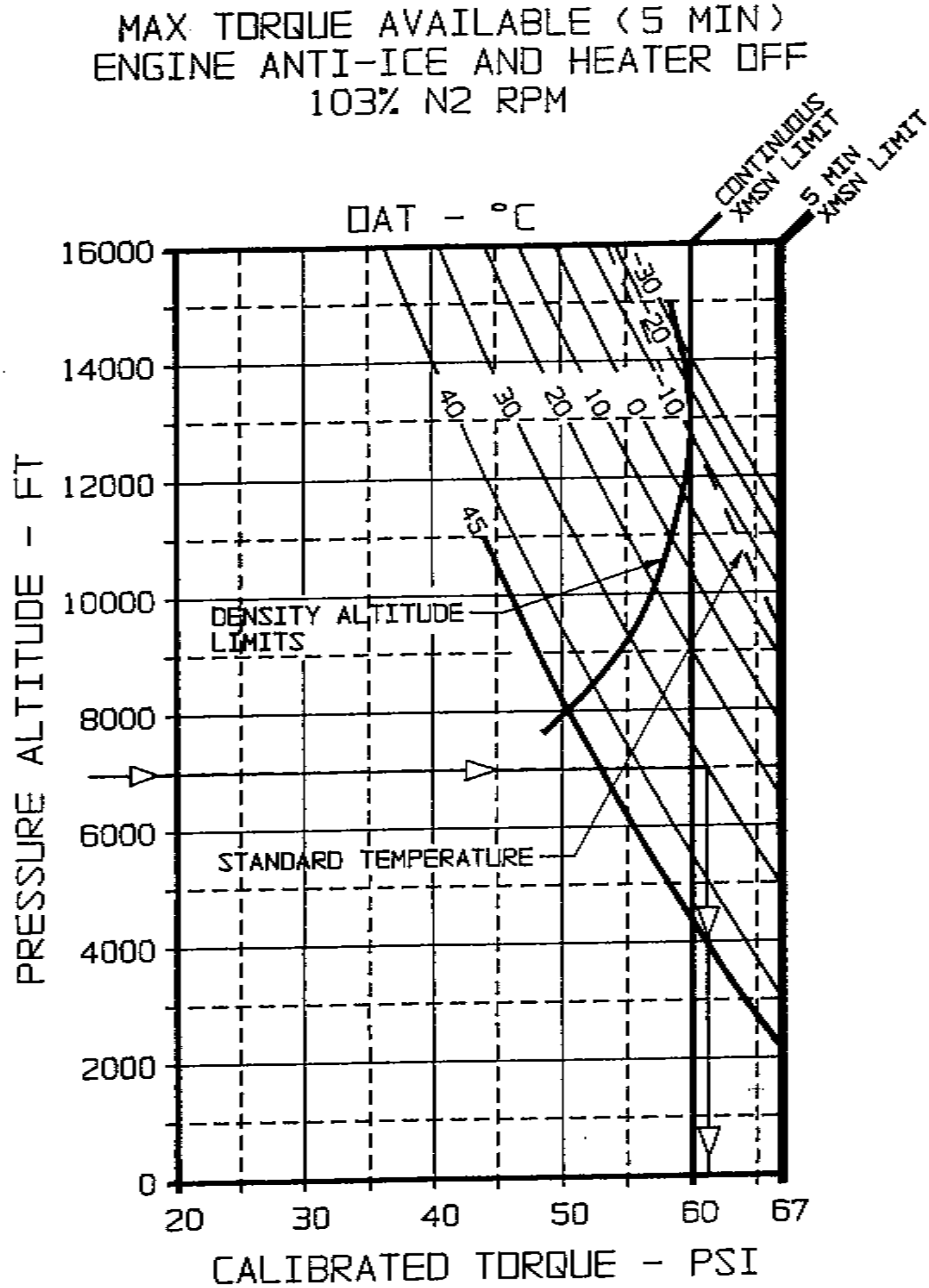
4-18. Conditions The maximum torque available chart is based upon engine speed of 103% N2 and main rotor speed of 364 RPM with Jet A fuel. The use of aviation gasoline will not influence engine power. Fuel grades Jet A, A-1, JP-4 and JP-5 will all yield the same nautical miles per pound of fuel. The heavier density of the JP-5 and Jet A type fuels will only result in increased fuel weight per gallon. Because JP-4, JP-5, and Jet A have the same energy value per pound, JP-5 and Jet A fuel will increase range by approximately 3-4 percent per gallon of fuel over JP-4.

EXAMPLE:

WANTED
CALIBRATED TORQUE

KNOWN
PRESS ALT = 7000 FT
OAT = 30°C

METHOD
ENTER PRESS ALT
MOVE RIGHT TO OAT



DATA BASIS: CALCULATED FROM MODEL SPEC C965 22SEP89. CORRECTED FOR INSTALLATION LOSSES BASED ON FLIGHT TEST.

NOTE: AT COMBINATIONS OF ALTITUDE AND TEMPERATURE WHERE THE TRANSMISSION 5 MINUTE RATING IS NO LONGER THE LIMITING FACTOR, WITH ENGINE ANTI-ICE ON THE MAXIMUM TORQUE AVAILABLE MAY BE AS MUCH AS 9.8 PSI LOWER THAN CHART VALUE.

FIGURE 4-6. MAXIMUM TORQUE AVAILABLE (5 MINUTE LIMIT)

SECTION V. HOVER

4-19. Description

The Hover Performance chart (Figure 4-9) shows weight limits, hover ceiling, and the torque required to hover at various pressure altitudes, ambient temperatures (OAT), gross weights, and skid heights.

4-20. Chart Uses

The primary use of this chart is illustrated by the example on the chart. It is necessary to use both the hover chart and the maximum torque available chart to determine the power margin for the intended operation. In general, to determine the hover ceiling or the torque required to hover it is necessary to know the pressure altitude, OAT, gross weight, and the desired skid height.

4-21. Conditions

The Hover Performance chart is based upon engine speed of 103% N2 and main rotor speed of 364 RPM, grade Jet A fuel, and a limiting engine TOT of 737 degrees C (1360 F), the engine maximum continuous TOT limit.

NOTE

The difference between the torque required to hover at the desired skid height, as determined from this chart, and the transmission structural limit (67 PSI), or the maximum torque available as determined from figure 4-6, will be the power reserve available for the intended flight operation.

INTENTIONALLY LEFT BLANK

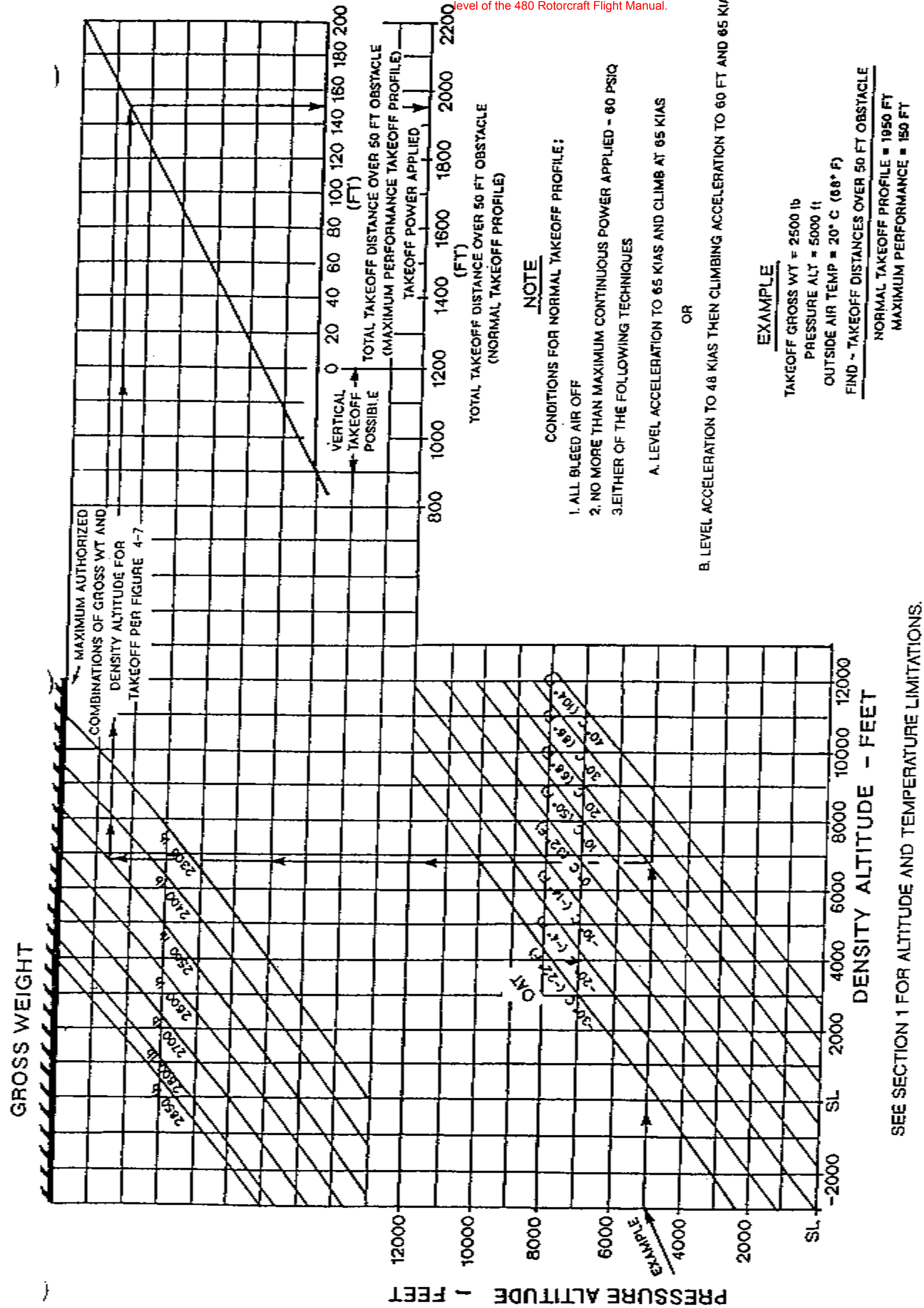


FIGURE 4-8. TAKEOFF PERFORMANCE

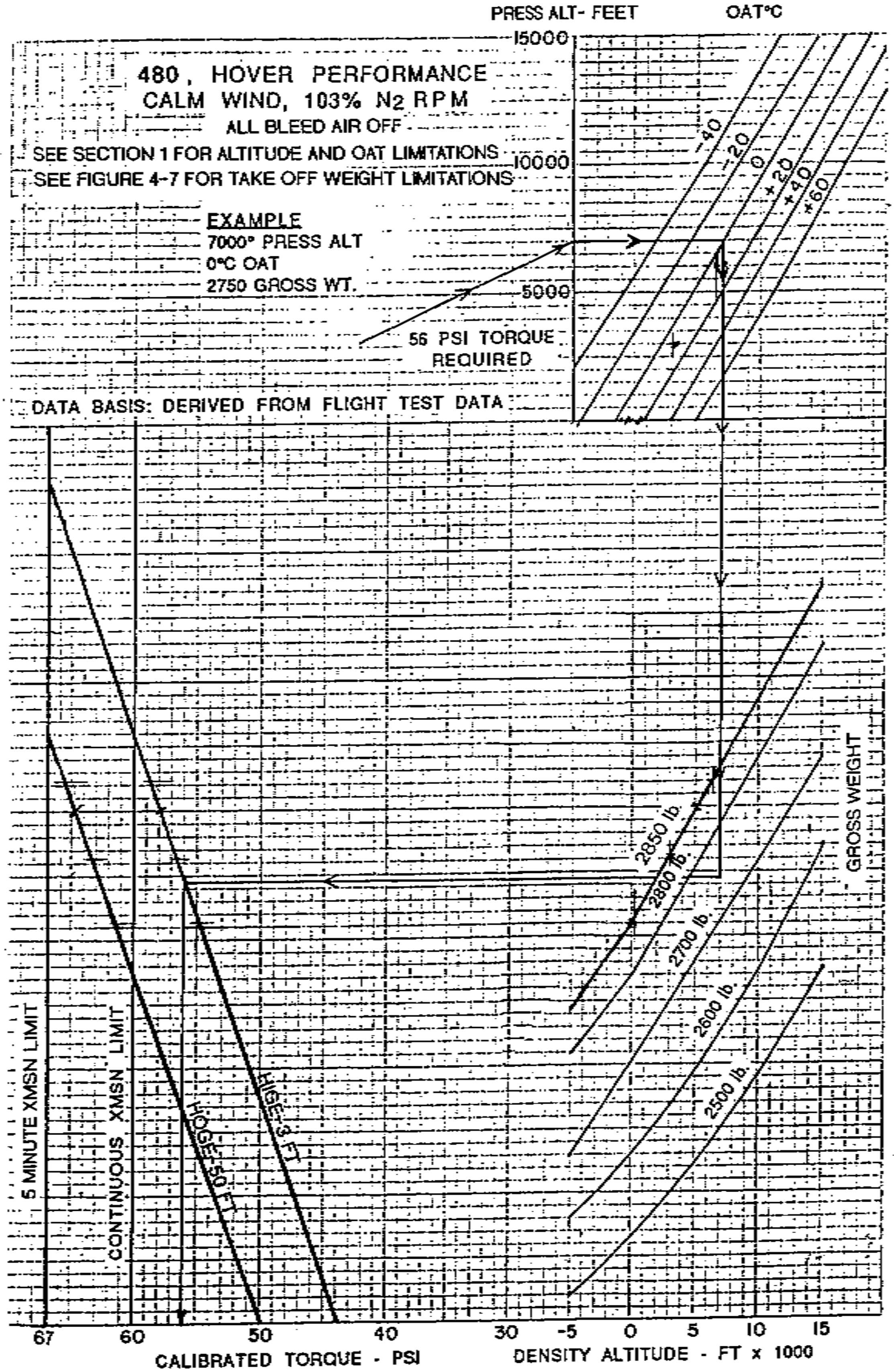


FIGURE 4-9. HOVER PERFORMANCE

SECTION VI. POWER ASSURANCE

4-22. Description The power assurance chart, Figure 4-10 provides the pilot a method for assuring that the installed engine will provide the necessary power required to achieve the performance presented in this manual.

4-23. Chart Use The primary use of this chart is illustrated by an example on the chart. The main consideration for the pilot is to ensure that the installed engine will deliver the power necessary for the helicopter to achieve the calculated performance. The engine power assurance chart provides a means for the pilot to double check the installed engine power prior to takeoff. This chart is intended to be used in the helicopter and, although the calculated hover torque, altitude, and OAT can be used during pre-flight mission planning to determine the expected TOT at a hover, the chart should be used to plot the actual data taken at a hover just prior to takeoff as the best means to determine that the calculated performance can be achieved. The pilot should come to a stabilized hover, record the pressure altitude, OAT, torque and TOT, then land and plot the actual data on this power assurance chart. If the actual TOT is less than or equal to the TOT determined from this chart then the helicopter can be expected to achieve the pre-flight calculated performance for the mission. If the actual TOT is above the TOT determined from the chart, the pilot should use his or her best judgement in deciding whether or not to continue the flight. The discrepancy could be a result of gradual engine deterioration, a dirty compressor, improperly rigged bleed air systems, FOD, or inaccuracies in the engine instruments. The most common solutions include inspecting the bleed air rigging and conducting a compressor wash or rinse. The discrepancy should be brought to the attention of maintenance personnel.

4-24. Conditions The conditions for this chart are 103% N_2 engine RPM and 364 rotor RPM at a stable hover. The skid height and wind conditions may have a slight effect, but since this is just a check of torque versus TOT at the ambient conditions present at takeoff the effect should be minimal.

NOTE

Because turbine engines do not completely stabilize for a few minutes after power is set, if the initial TOT at a hover fails to meet the power assurance chart criteria, it may be necessary to repeat the test by hovering for at least two minutes before retaking the data to confirm the engine performance.

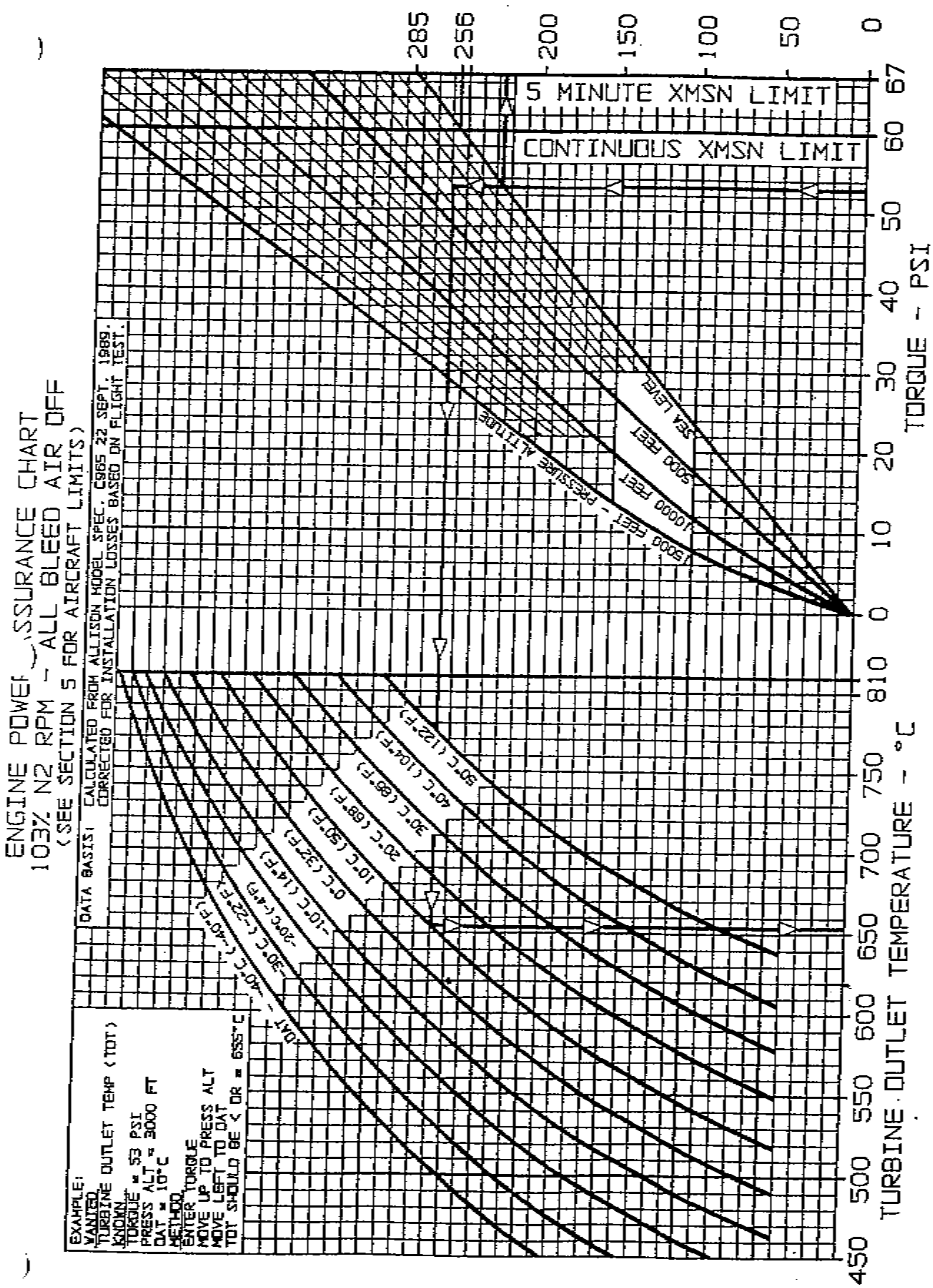


FIGURE 4-10. ENGINE POWER ASSURANCE CHART

SECTION VII. CRUISE

4-25. Description The cruise charts (Figure 4-11.1 through 4-11.3) show the torque pressure and fuel flow required for level flight at the various pressure altitudes, airspeeds, and gross weights.

4-26. Chart Use The first step for chart use is to select the proper chart, based upon the pressure altitude. Normally, sufficient accuracy can be obtained by selecting the chart nearest to the planned cruising altitude, or the next higher altitude. If greater accuracy is required, interpolation between altitudes will be required. You may enter the charts on any side, TAS, Torque pressure, or fuel flow, and then move vertically or horizontally to the gross weight, then to the other parameters. Maximum performance conditions are determined by entering the chart where the maximum range or maximum endurance and rate of climb lines intersect the appropriate gross weight; then read airspeed, fuel flow, and torque pressure. For conservatism, use the gross weight at the beginning of the flight. The following parameters contained in each chart are further explained as follows:

a. Airspeed. True airspeed is shown at the bottom of each chart.

b. Torque (PSI). Since pressure altitude and temperature are fixed for each chart, torque varies according to gross weight and airspeed.

c. Fuel Flow. Fuel flow is provided as a separate chart. All fuel flow information is presented with particle separator, engine anti-ice, heater and defroster off.

d. Maximum Range. The maximum range lines indicate the combinations of weight and airspeed that will produce the greatest flight range per gallon of fuel under zero wind conditions.

NOTE

V_{NE} is not shown on these charts because it varies with OAT and takeoff C.G. See Chapter 1 for V_{NE} limitations. Where V_{NE} is less than the airspeed indicated for maximum range, maximum range will be obtained at V_{NE}.

e. Maximum Endurance and Maximum Rate of Climb. The maximum endurance lines indicate the airspeed for minimum torque required to maintain level flight for each gross weight, OAT, and pressure altitude. Since minimum torque will provide minimum fuel flow, maximum flight endurance will be obtained at the airspeeds indicated. Maximum rate of climb will also occur at this airspeed as it provides the greatest excess torque.

4-27. Conditions The cruise charts are based upon operation at 103% engine N2 RPM, engine anti-ice, particle separator, defroster, and heater off.

NOTE

At constant speed and shaft horsepower, turning engine anti-ice on may increase fuel flow by 20%, thus decreasing overall range and time aloft by an equal amount.

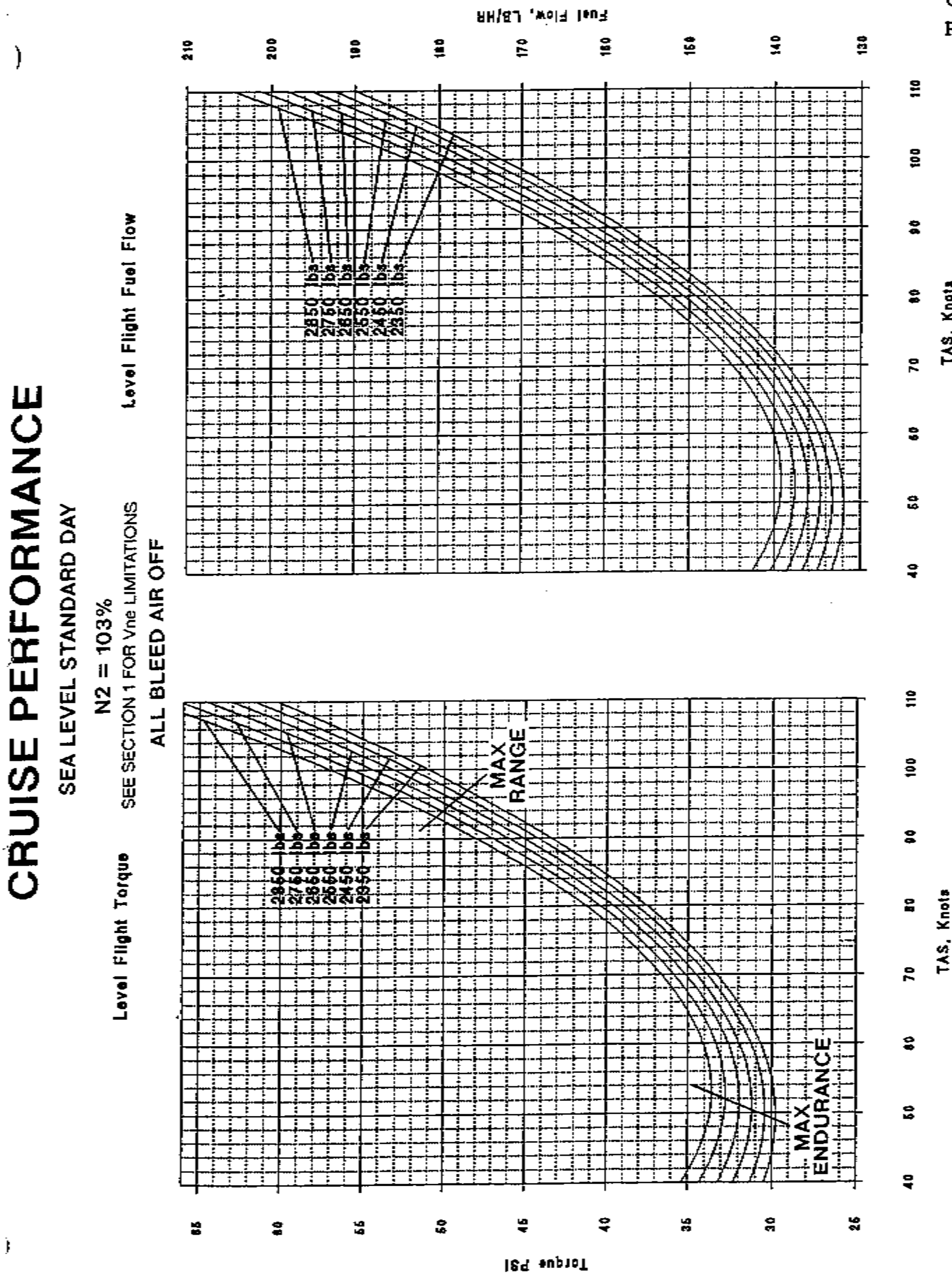


FIGURE 4-11.1 CRUISE PERFORMANCE - AT SEA LEVEL

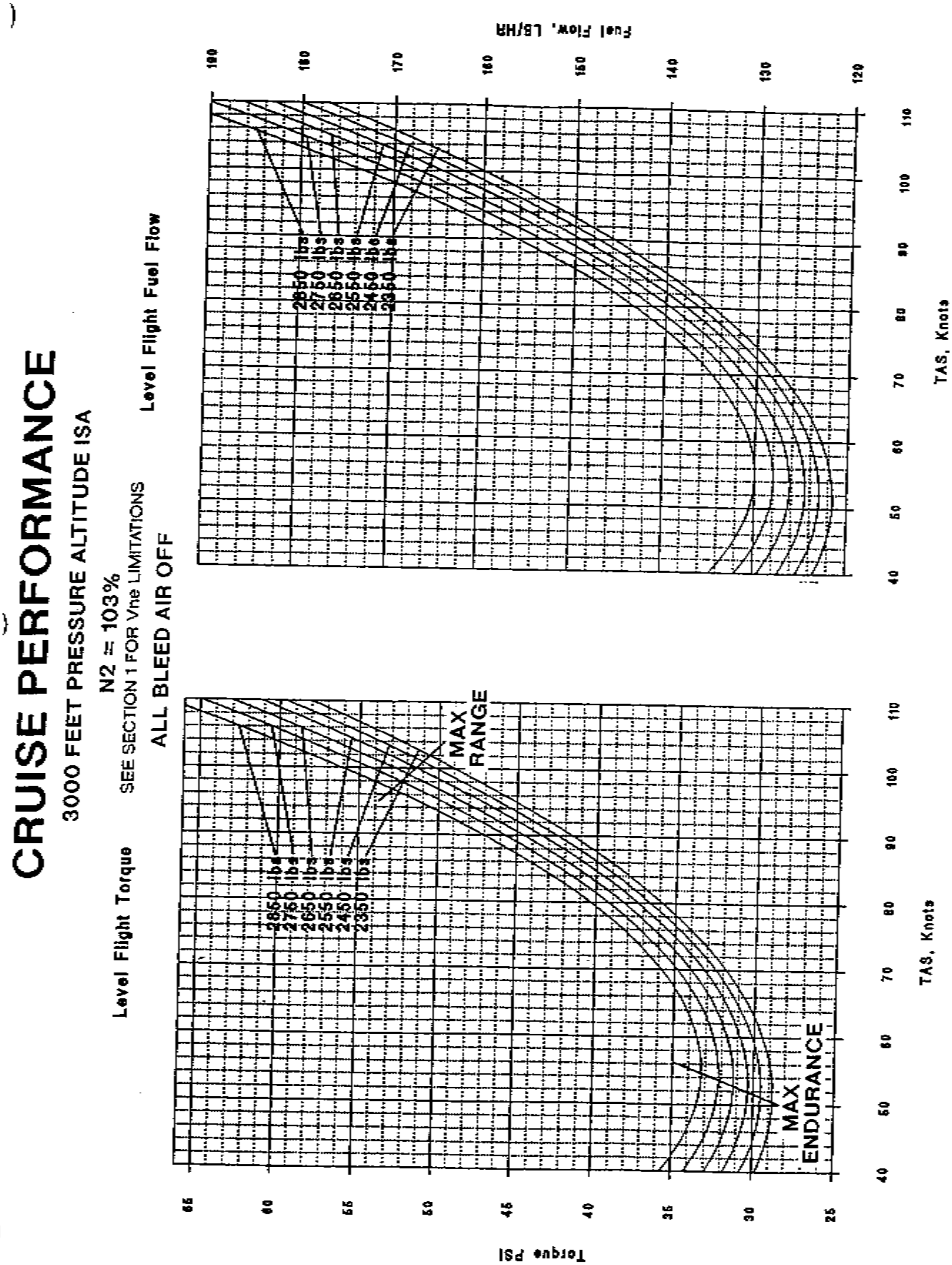


FIGURE 4-11.2 CRUISE PERFORMANCE - AT 3000 FT

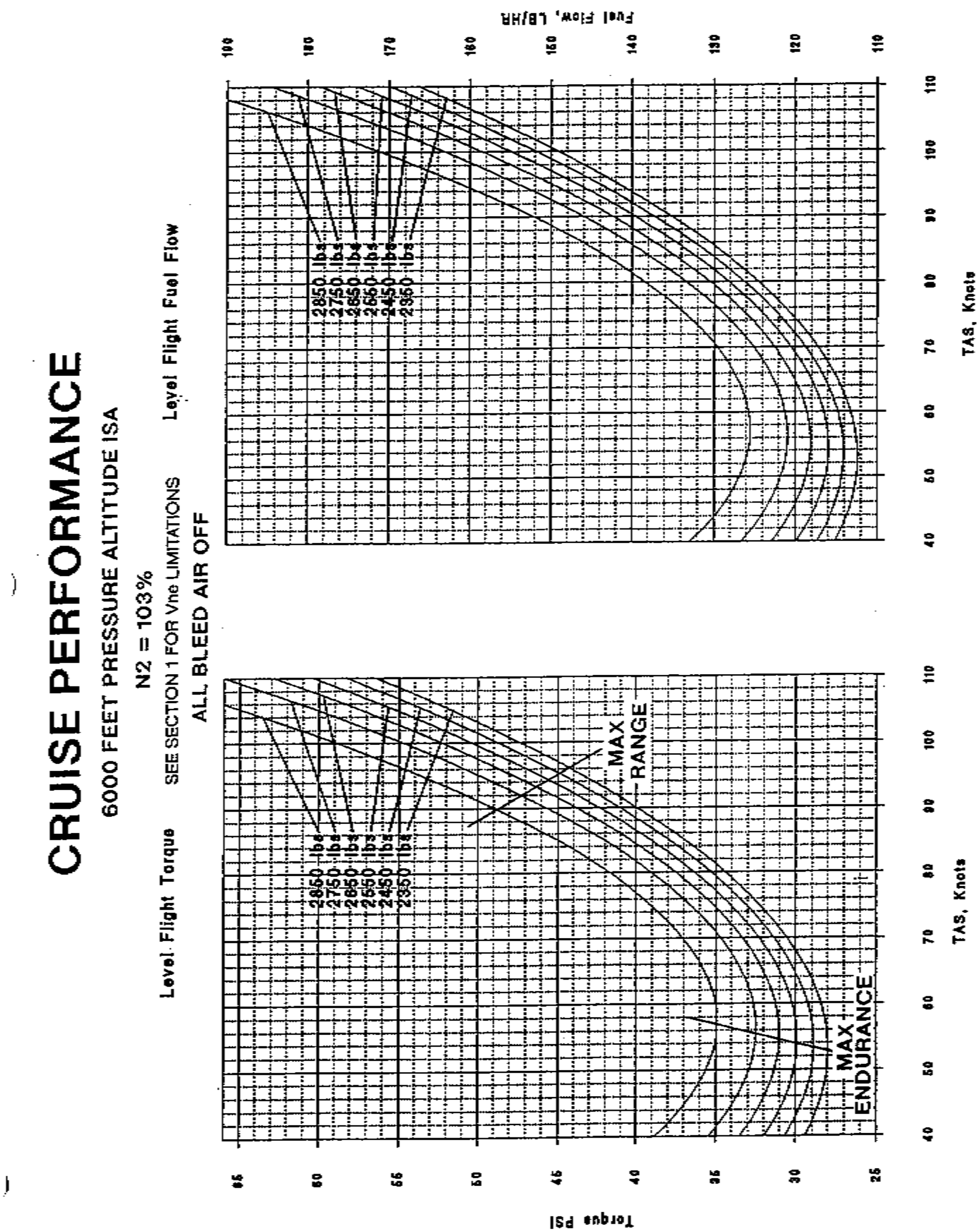


FIGURE 4-11.3 CRUISE PERFORMANCE - AT 6000 FT

SECTION VIII. CLIMB - DESCENT

4-28. Description The upper grid of the climb-descent chart, Figure 4-12, shows the change in torque (above or below the torque required for level flight under the same gross weight and atmospheric conditions) to obtain a given rate of climb or descent. The lower grid of the chart shows the relationship between descent-climb angles, airspeeds, and rates of climb or descent.

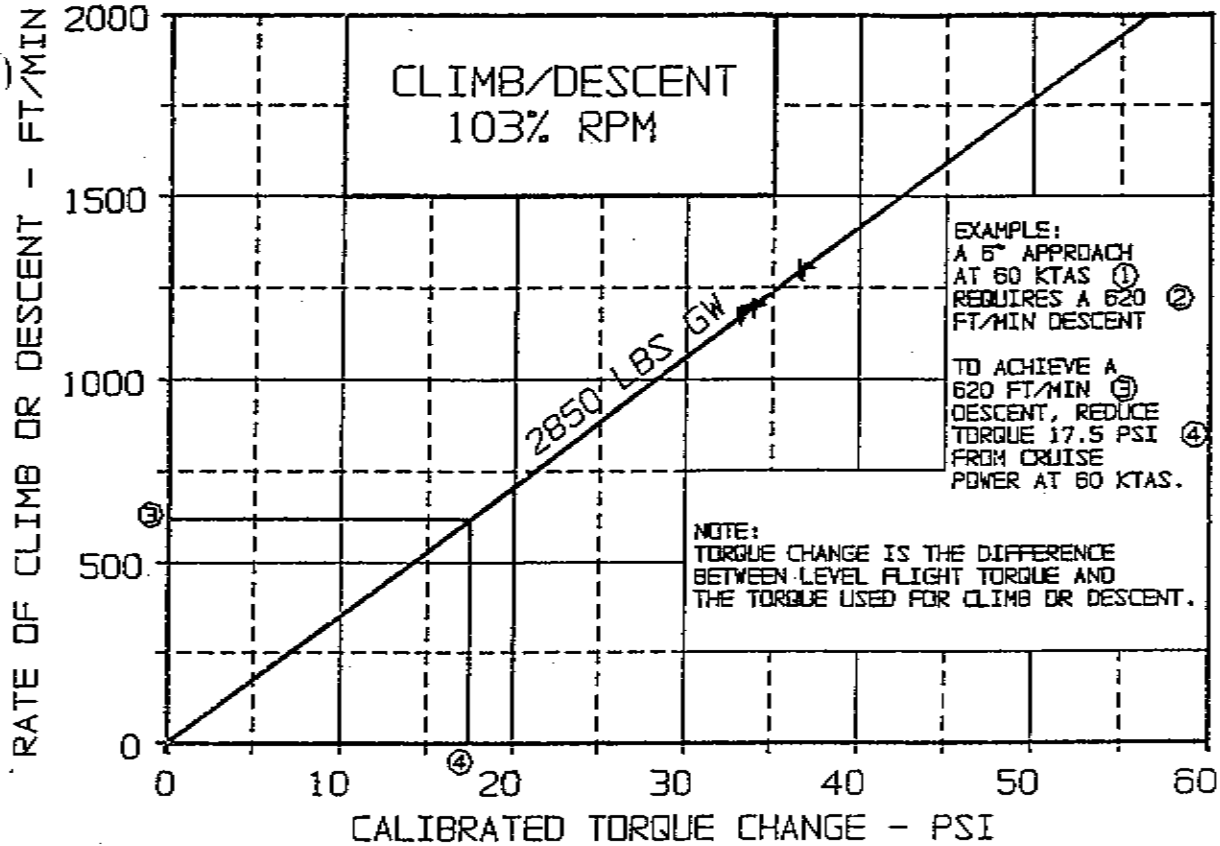
4-29. Chart Use The primary use of this chart is illustrated by the chart example.

a. The torque change obtained from the upper grid scale must be added (for climb) - or subtracted (for descent) - to the torque required for level flight obtained from the appropriate cruise chart to obtain a total climb or descent torque.

b. A rate of climb or descent may be obtained by entering the bottom of the upper grid with a known torque change, moving upward to the gross weight, and left to the corresponding rate of climb or descent.

c. By entering the lower grid chart with any two of the three parameters the remaining parameter can be determined.

4-30. Conditions The climb - descent chart is based on the use of 103% engine N2 RPM, 364 rotor RPM and 2,850 lbs. gross weight.



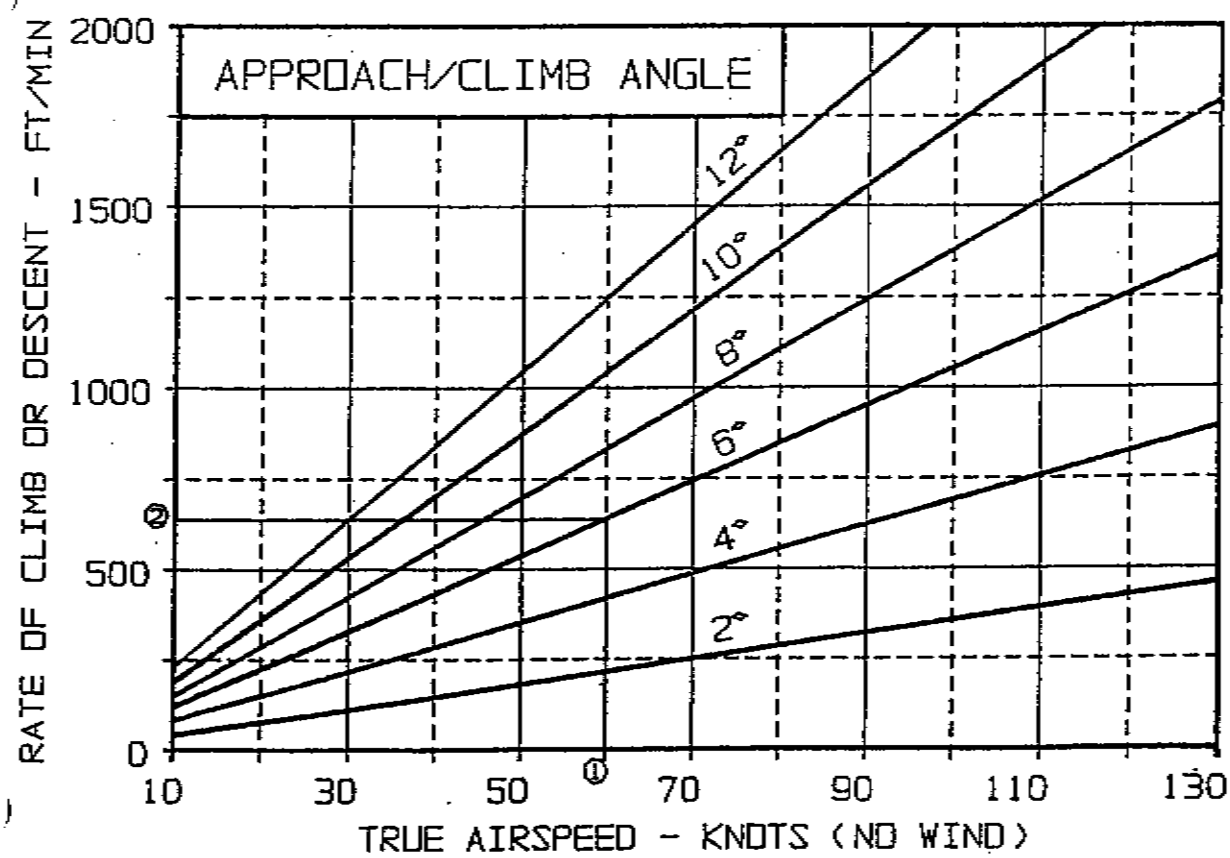


FIGURE 4-12. CLIMB / DESCENT RATE AND ANGLE

SECTION IX. CLIMB PERFORMANCE

4-31. Description The climb performance charts, Figure 4-13 and 4-14, show the optimum climb speed (calibrated airspeed versus density altitude), and the expected rate of climb, fuel used, distance, and time to climb as a function of takeoff gross weight.

4-32. Chart Use The primary use of these charts is illustrated by the examples on each chart.

4-33. Conditions These charts represent climb at the optimum conditions and also allow the pilot to determine the effect of off optimum operating conditions on the climb performance. Climb as limited by the continuous power torque and engine rating are shown to allow the pilot to determine the in flight climb performance of the aircraft. No data is shown for the 5 minute power rating as that is considered a contingency rating for initial obstacle clearance takeoff. The climb charts are based on 103% N2 rpm and 364 rotor RPM in a no-wind condition. Actual performance will vary from the calculated performance when winds are present.

BEST RATE OF CLIMB SPEED VARIATION WITH ALTITUDE
MAXIMUM CONTINUOUS POWER
N_2 = 103% RPM
GROSS WEIGHT = 2,850 POUNDS

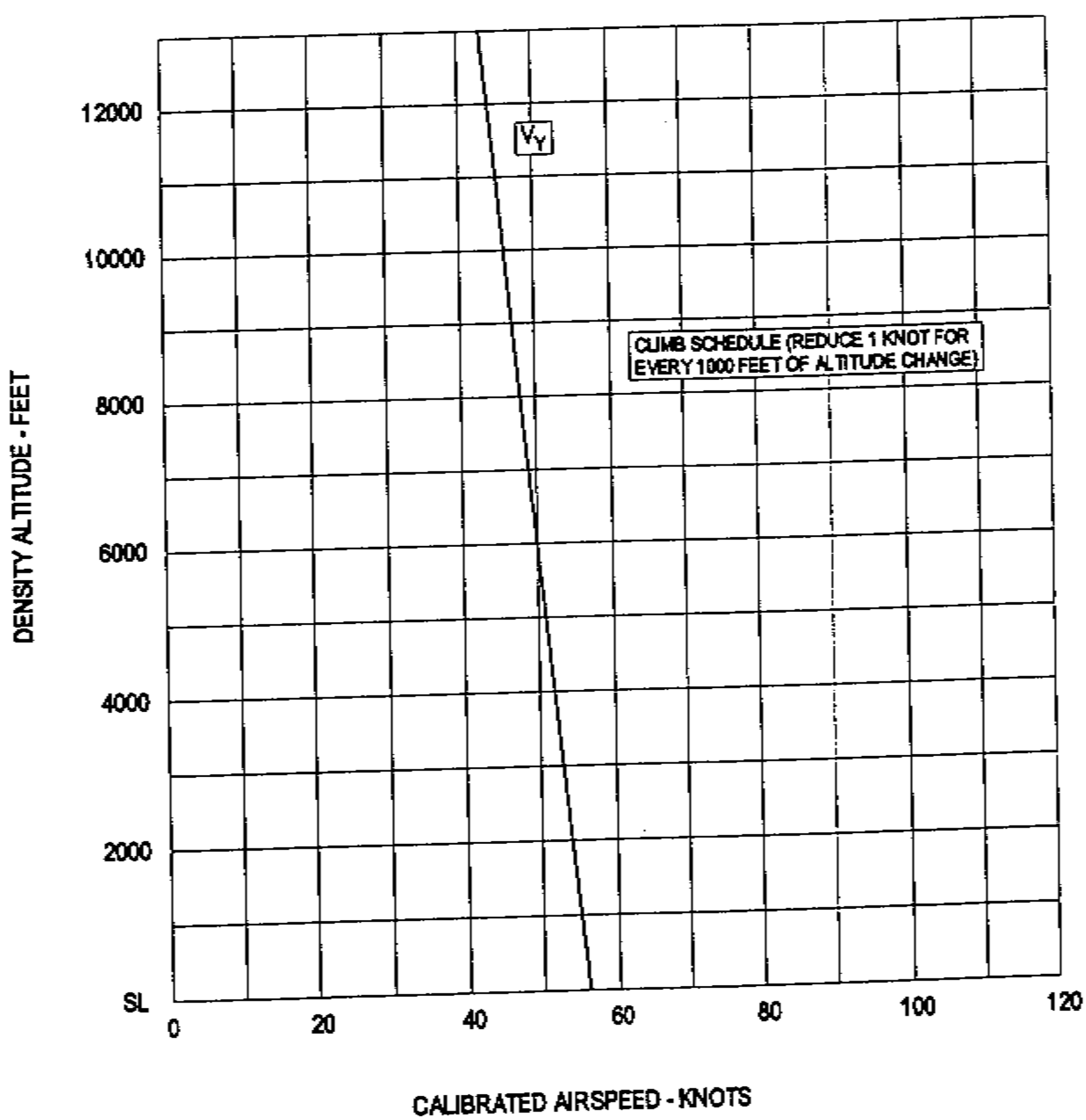


FIGURE 4-13. CLIMB

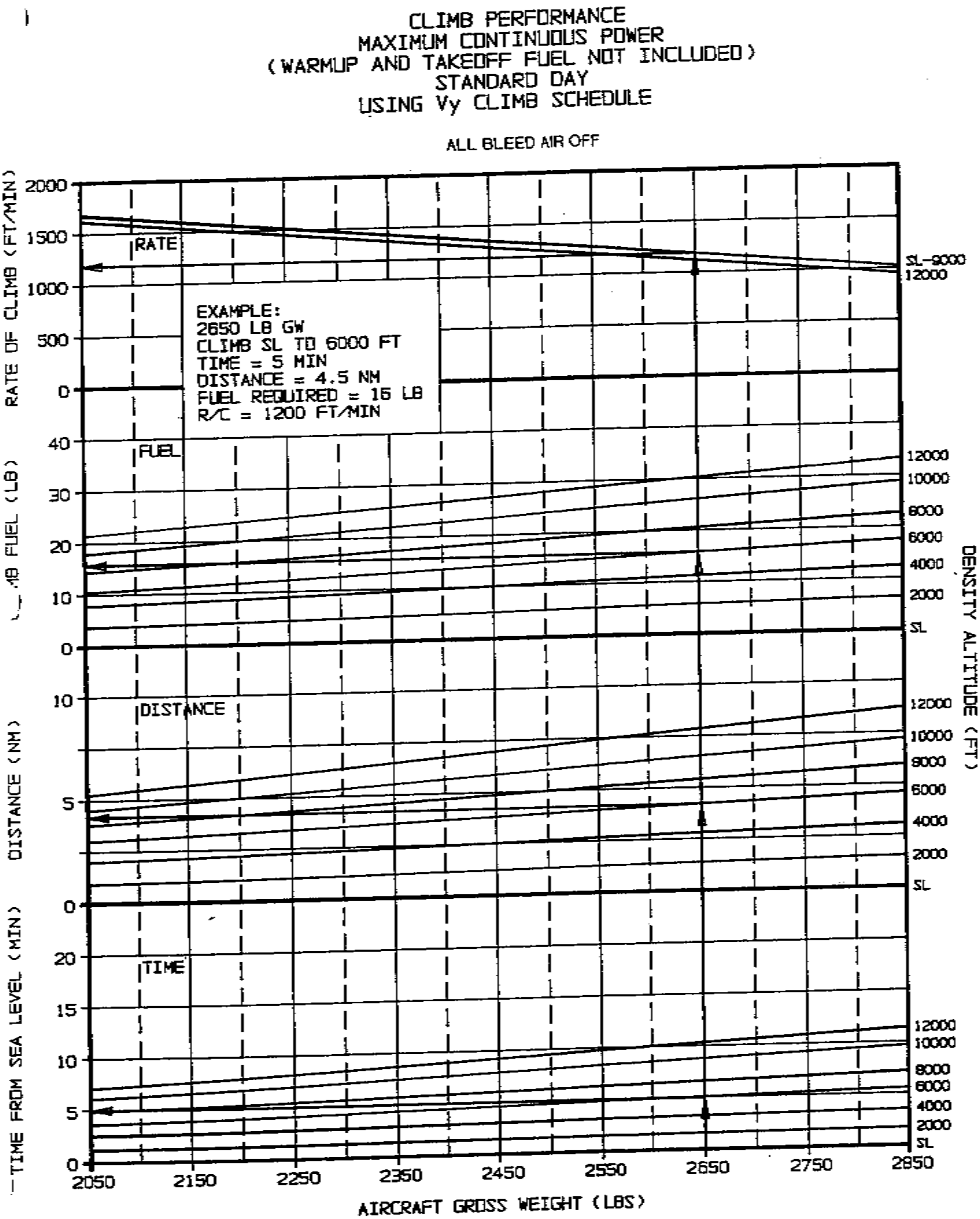


FIGURE 4-14. CLIMB PERFORMANCE

SECTION X - AUTOROTATION

4-34. Height-Velocity Diagram

The Height-Velocity Diagram is shown in Figure 4-15. Each curve was developed at the weight and altitude conditions specified.

4-35. Minimum Rate of Descent - Power Off

Below 6000 feet density altitude, the minimum rate of descent is attained at an indicated airspeed of approximately 50 KIAS and 334 rotor RPM. Above 6000 density altitude the airspeed for minimum rate of descent decreases 2 knots per 1000 feet. (See Figure 4-16). At airspeeds below 50 KIAS the rate of descent increases and glide distance decreases.

4-36. Maximum Glide Distance - Power Off

The maximum glide distance is attained at an indicated airspeed of approximately 80 KIAS and 334 rotor RPM at sea level. The airspeed decreases 2 knots for each 1000 feet density altitude above sea level (see Figure 4-16). Refer to Figure 4-17, Maximum Glide Distance in Autorotation, for glide distance in autorotation.

4-37. Rotor RPM Control - Power Off

Rate of descent will increase as the rotor RPM increases from 334 RPM. Refer to Figure 4-18, Variation of Rate of Descent with Rotor RPM in Autorotation.

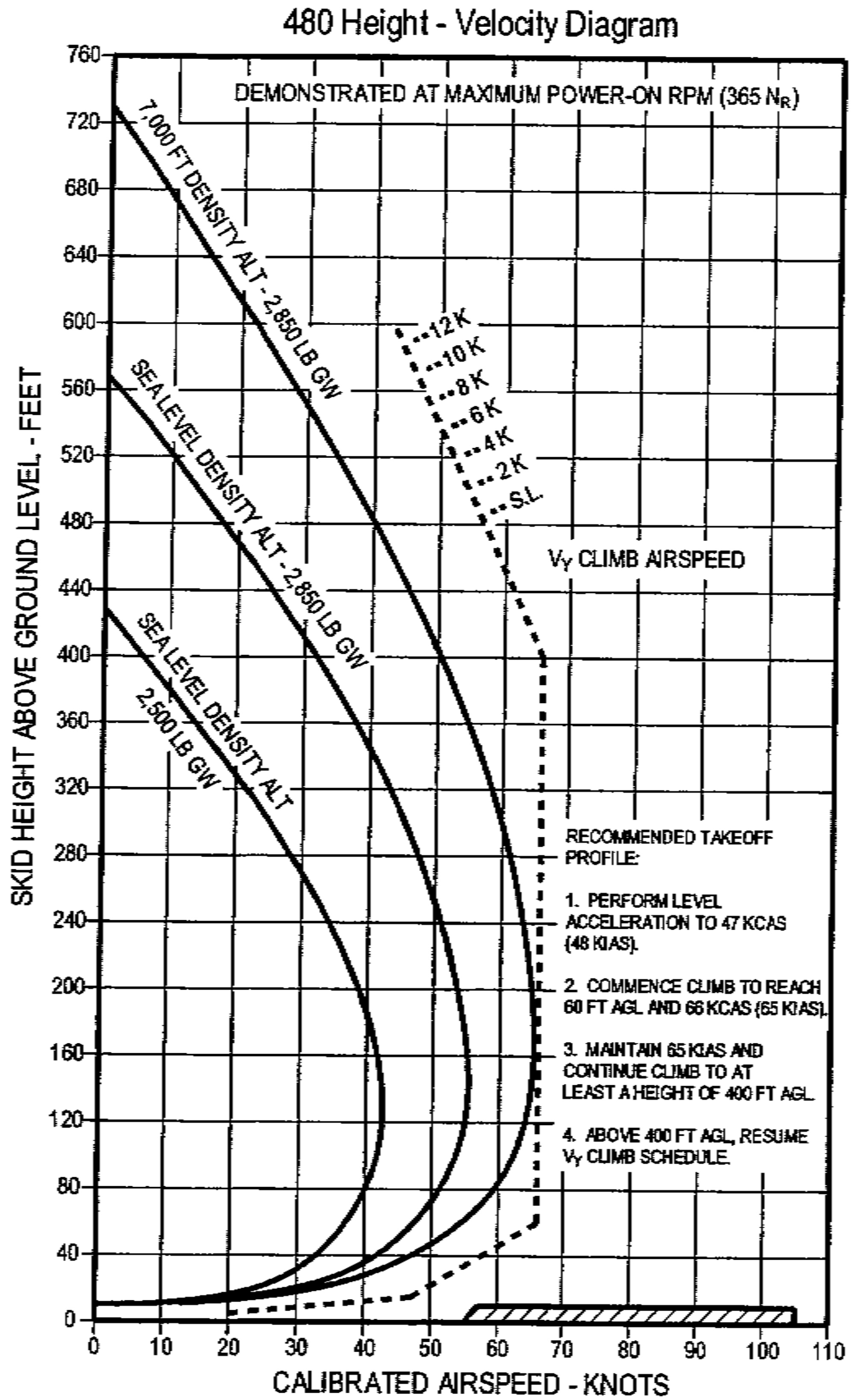


Figure 4-15. Height-Velocity Diagram

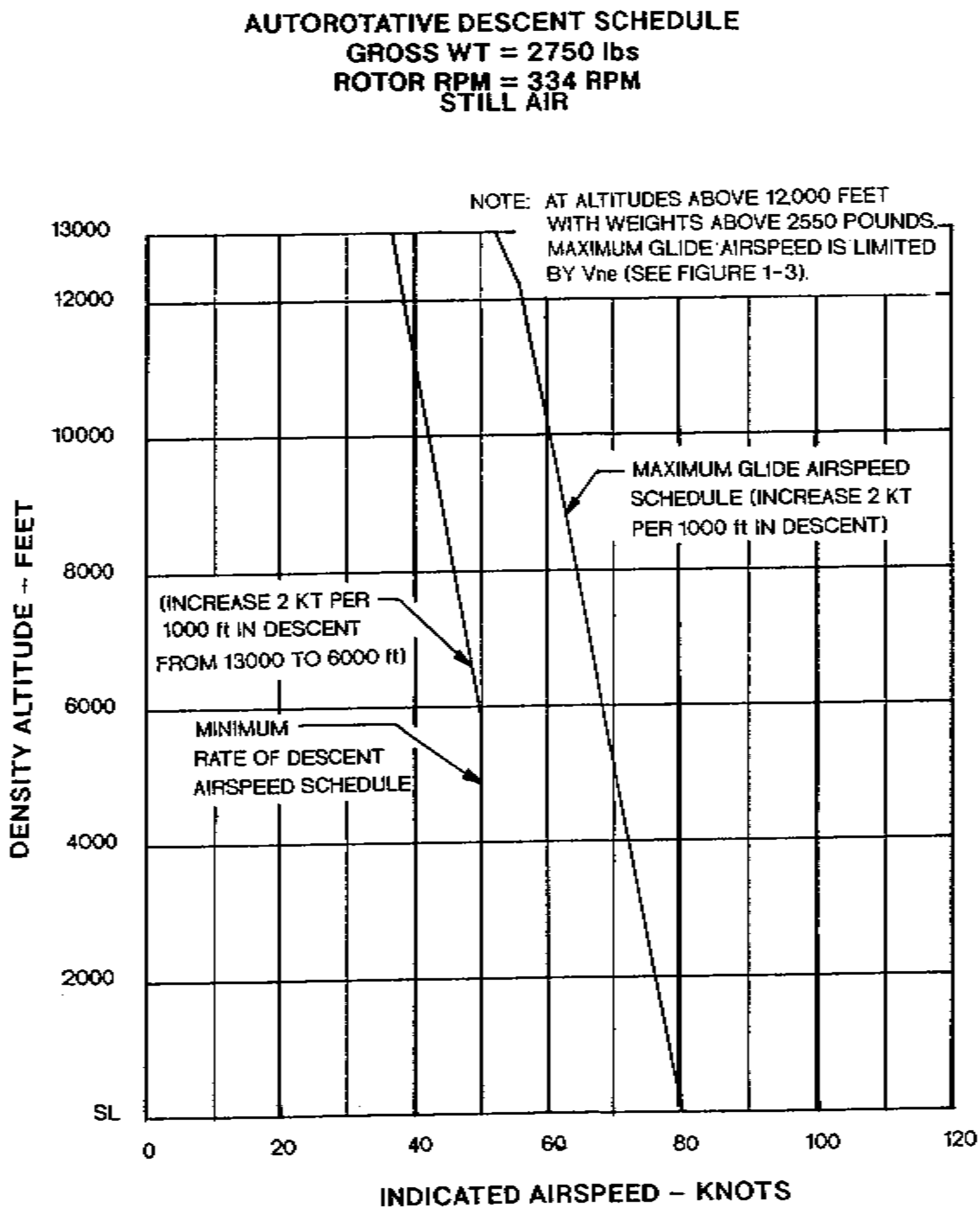


FIGURE 4-16. AUTOROTATIVE DESCENT SCHEDULE

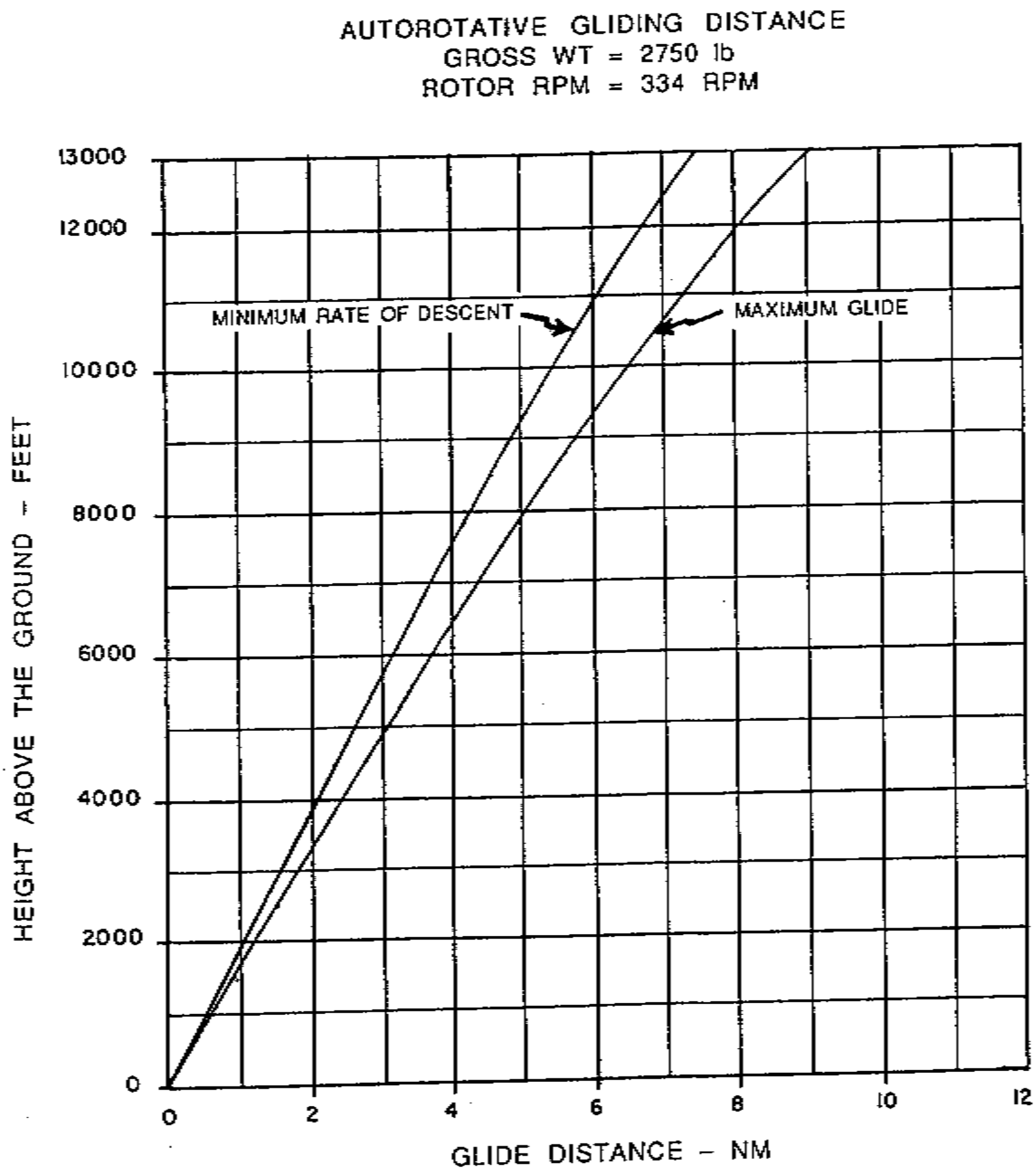


FIGURE 4-17. MAXIMUM GLIDE DISTANCE IN AUTOROTATION

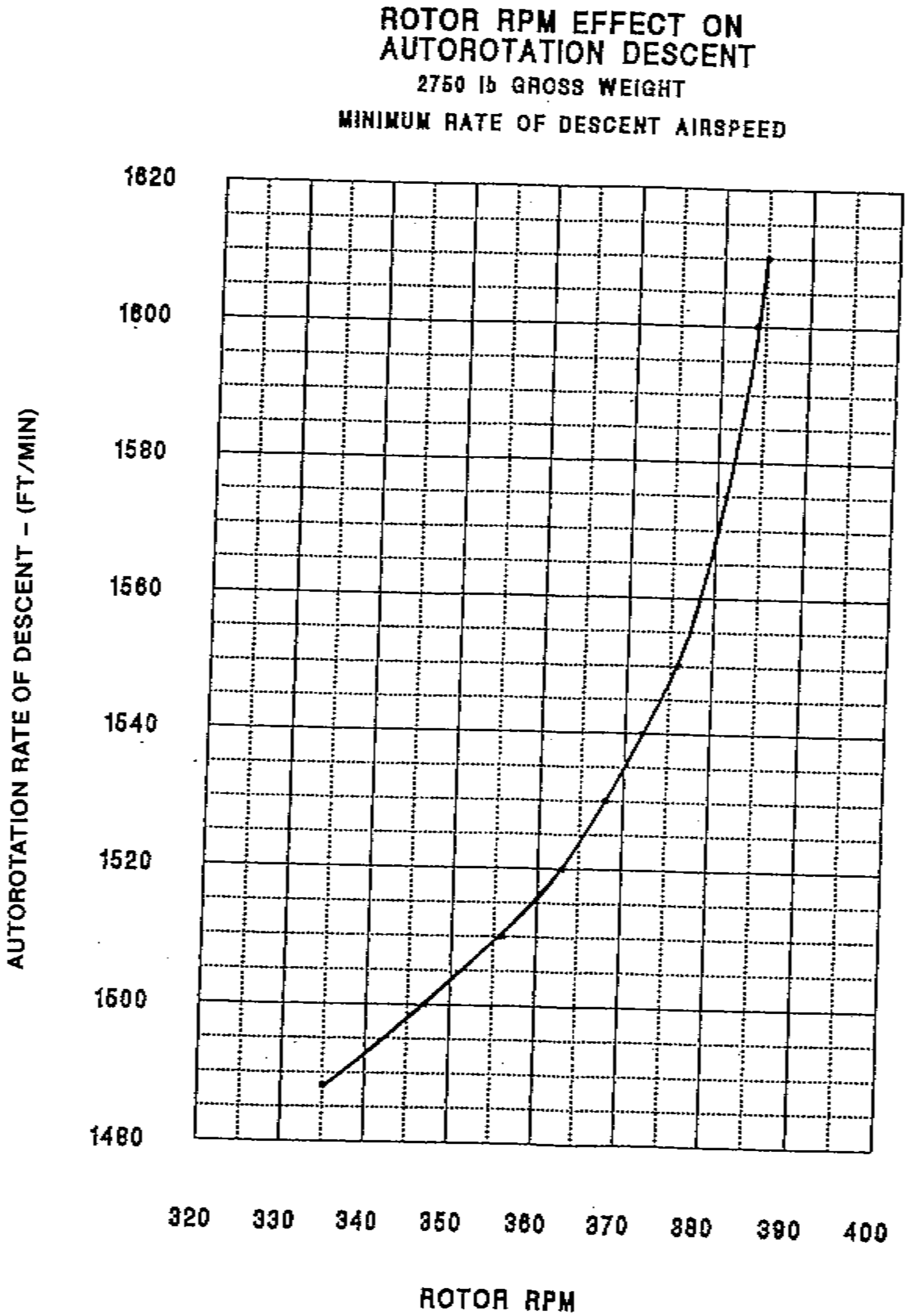


FIGURE 4-18. VARIATION OF RATE OF DESCENT WITH ROTOR SPEED

SECTION XI - NOISE

4-38. Noise.

In accordance with Appendix J of FAR36, the fly-over noise level at a reference airspeed of 91 KTAS is 82.4 dBA. No determination has been made by the Federal Aviation Administration that the noise levels of this aircraft are or should be acceptable or unacceptable for operation at, into, or out of any airport.

CHAPTER 5

OPTIONAL EQUIPMENT SUPPLEMENTS

TABLE OF CONTENTS

LIST OF FIGURES

SUPPLEMENT NUMBER 1

CARGO HOOK

SECTION I. GENERAL

5-1-1. Introduction

This supplement must be attached to the Basic Flight Manual when the Enstrom Cargo Hook Kit No. 4220024 is installed and utilized for transportation of external cargo. Operation in compliance with Chapter 1, Operating Limitations, of the Basic Flight Manual is mandatory except as modified by this supplement. Other approved sections and supplemental data are recommended procedures.

5-1-2. Description

This aircraft is certified for operation at gross weights up to 2850 pounds (1292 kg) for Restricted category cargo hook operation. A log book entry shall be made when changing category of operation.

The cargo hook kit, part number 4220024, comprises a Breeze-Eastern 2A20B cargo hook suspended below the pylon by four cables. The Hook incorporates an electrical release on the cyclic along with an emergency mechanical release mounted on the pilot's collective. After the initial installation of the cargo hook kit, the cargo hook and suspension cables can be removed or installed without tools.

NOTE

A swivel link is not supplied with the Cargo Hook Kit; however, it is recommended that a swivel link be installed between the suspension cable and the cargo hook.

SECTION II. OPERATING LIMITATIONS

5-1-3. Type of Operation This aircraft is approved for multiple certificate operation under FAR 133 for Class B Rotorcraft-Load Combinations.

Normal operations may be conducted under FAR Part 91 with the cargo hook installed, providing external cargo is not being transported.

5-1-4. Weight The total weight of this helicopter and load combination shall not exceed 2850 pounds (1292 kg).

The maximum external load is 1000 pounds (454 kg).

5-1-5. Center of Gravity Limitations See Figure 5.1.1., weight and balance.

5-1-6. Airspeed Limitations The maximum airspeed when operating with an external load is 80 knots or the appropriate airspeed shown in figure 1-3 of the Basic Flight Manual, whichever is lower.

CAUTION

Airspeed with external loads may be limited by controllability. The maximum safe airspeed for satisfactory handling characteristics is dependant upon many variables such as shape, CG of the load, length of the sling, location of the suspension points, and rate of climb or descent. Caution should be exercised as the onset of unsatisfactory handling characteristics may be very abrupt.

5-1-7. Altitude Limitations Same as the Basic Flight Manual.

5-1-8. Rotor Limitations Same as the Basic Flight Manual.

5-1-9. Engine and Transmission Limitations Same as the Basic Flight Manual.

5-1-10. Placards

a. These placards must be place in view of the pilot:

APPROVED FOR CLASS B ROTORCRAFT-LOAD OPERATION. OCCUPANCY LIMITED TO ESSENTIAL CREW ONLY WHEN CARRING EXTERNAL LOAD.

WITH EXTERNAL LOAD, VNE IS THE LOWER OF 80 KNOTS OR AS SHOWN IN FIG. 1-3.

b. This placard is to be installed on the cargo hook:

EXTERNAL LOAD LIMIT 1000 LBS (454 KG)

5-1-11. Preflight Operation Check

a. Visual Preflight Check

1. Inspect cargo hook condition and security.

2. Inspect four suspension cables and their attaching hardware for security and condition.

3. Inspect Manual Release cable and Electrical Release wiring and attachments for security and condition.

b. Electrical Release System

1. Turn Master Switch ON.

2. Turn Cargo Release Arm switch ON.

3. Place a load on the cargo hook beam.

4. Press the Cargo Hook Release switch on the pilot's cyclic grip and note that the hook releases. If the Cargo Hook Release switch is held ON, the hook will not relatch. After the switch is released, the hook will relatch.

5. Turn the Cargo Release Arm and Master switches OFF.

c. Manual Release System

1. Place a load on the cargo hook beam.

2. Pull the Manual Release handle on the Pilot's Collective and note that the cargo hook releases. There should be at least 3/4-inch between the release handle and the collective when the cargo hook releases.

3. After the hook has released, lower the manual release handle and note that the hook relatches.

5-1-12. Static Electricity Discharge The helicopter must be grounded before coming into contact with any ground personnel or picking up the load. Provide the ground crew with the following instructions: Discharge the helicopter static electricity before attaching the cargo by touching the airframe with a ground wire. If a metal sling is used, the helicopter can be grounded by striking the hook-up ring against the cargo hook. If contact is lost after initial grounding, the helicopter should be regrounded. Electrical ground contact should be maintained until the hook-up is completed.

5-1-13. Cargo Hook Operation Turn the Cargo Release Arm switch OFF in steady cruise flight. Turn the Cargo Release Arm switch ON as desired during hook-up, Take-off and climb-out, and approach for release. To release the cargo, Press the cargo release button on the cyclic grip.

NOTE

The Cargo Release button on the cyclic grip will not operate if the Cargo Release Arm switch is OFF.

SECTION IV. EMERGENCY PROCEDURES

5-1-14. Electrical Failure Pull the manual release handle located on the bottom of the pilot's collective to drop the external load as desired in the event of an electrical failure or if the electrical release fails to operate.

NOTE

The manual cargo release will operate regardless of the position of the CARGO RELEASE ARM switch.

SECTION V. PERFORMANCE

5-1-15. Use the data published in the Basic Flight Manual. Note however that the climb and cruise performance may be significantly reduced dependent upon the configuration of the external load.

SECTION VI. WEIGHT AND BALANCE

5-1-16. A new weight and balance should be recalculated per the instructions in section 6 of the Basic Flight Manual using the information listed below. Note that a portion of the cargo hook installation normally remains in the aircraft even with hook removed. This is listed as the "Non-removable Installation."

	Weight (lbs)	Arm (in)	Moment (in-lbs)
Cargo Hook			
Non-removable Installation	2.48	136.33	338.1
Removable Installation	9.08	140.80	1278.4
External Load	XX	139	(XX)x139

The Center of Gravity Limits remain the same as listed in the Basic Flight Manual with the exception of the extension in the aft c.g. limit at weights above 2500 lbs up to 2850 lbs. The maximum aft c.g. limit at and below 2850 lbs for cargo hook operations is 143.0 inches. See figure 5.1.1

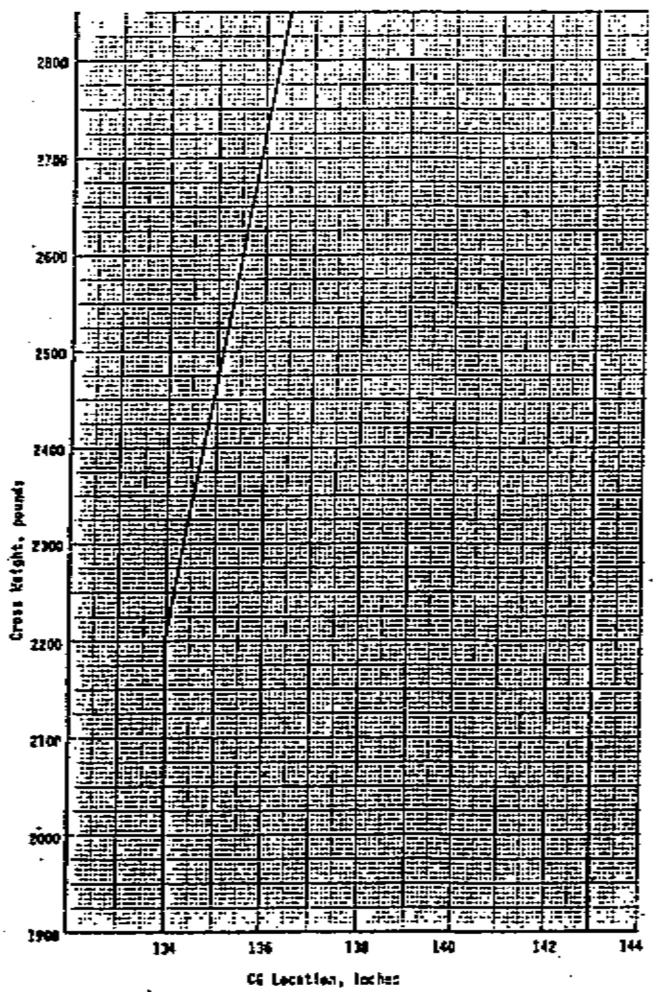


Figure 5.1.1

TABLE OF CONTENTS

SUPPLEMENT NUMBER 2

SNOWSHOE

SECTION I - GENERAL

5-2-1. Introduction This supplement must be attached to the Basic Flight Manual when the Enstrom Snowshoe Kit No. 4220016 is installed on the helicopter. Operation in compliance with Section 1, Operating Limitations, is mandatory except as modified by this supplement. Other approved sections and supplemental data are recommended procedures.

NOTE

This snowshoe kit, P/N 4220016, is unavailable in France.

5-2-2. Description The snowshoe kit consists of four snowshoe pads, two on each skid tube. These pads increase the footprint of the landing gear, allowing landings in various snow conditions. The forward pads are 2 sq-ft (.19 sq-m) each, and the aft pads are 3.2 sq-ft (.3 sq-m) each.

SECTION II. OPERATING LIMITATIONS

5-2-3. The aircraft may be operated with all four snowshoes installed, only the aft snowshoes installed, or without snowshoes. Other combinations are not authorized.

SECTION III. NORMAL PROCEDURES

5-2-4. Add the following to the "Exterior Check":

Paragraph 2-11:
9) Snowshoes - Left Side: Check security and condition of Forward and Aft pads. Look for missing hardware and damage to pads or skid.

Paragraph 2-14:
6) Snowshoes - Right Side: Check security and condition of Forward and Aft pads. Look for missing hardware and damage to pads or skid.

SECTION IV. EMERGENCY PROCEDURES

5-2-5. Same as Basic Flight Manual.

SECTION V. PERFORMANCE

5-2-6. Same as Basic Flight Manual.

SECTION VI. WEIGHT AND BALANCE

5-2-7. A new weight and balance should be recalculated per the instructions in section 6 of the Basic Flight Manual using the information listed below.

	Weight (lbs)	Arm (in)	Moment (in-lbs)
Aft Snowshoes	21.0	161.6	3394
Aft Skid Wear Plates (Removed)	-2.0	160	-320
Forward Snowshoes	9.0	100	900
Forward Skid Wear Plates (Removed)	-1.6	100	-160

TABLE OF CONTENTS

SUPPLEMENT NUMBER 3

EXTERNAL FUEL FILTER

SECTION I. GENERAL

5-3-1. Introduction This supplement must be attached to the Basic Flight Manual when the Enstrom External Fuel Filter Kit No. 4220035 is installed on the helicopter. Operation in compliance with Section 1, Operating Limitations, is mandatory except as modified by this supplement. Other approved sections and supplemental data are recommended procedures.

5-3-2. Description The External Fuel Filter Kit comprises a Facet Filter Products Division P/N 1743640-01 filter in the main fuel line between the fuel shutoff valve and the engine. The filter incorporates a sump drain valve and a filter bypass with an impending bypass caution light.

SECTION II. OPERATING LIMITATIONS

5-3-3. Same as Basic Flight Manual.

SECTION III. NORMAL PROCEDURES

5-3-4. Add the following to the Exterior Check, Paragraph 2-11, "Aft Fuselage - Left Side - Area 2":
9) Fuel Filter:

a. Check security and condition.

b. Check lines for leaks and tightness.

c. With master switch on, depress impending bypass test button located on top of the external fuel filter - the A/F FUEL FILTER light should come on.

Add the following to Paragraph 2-19, "Engine Runup":
16) Impending Bypass Caution Light - Check impending bypass caution light. If the light is ON, the filter must be serviced before further flight.

5-3-5.

a. Upon an in-flight indication of the A/F FUEL FILTER light, the pilot should perform a power on approach and land as soon as practicable and check the fuel filter for contamination.

b. Upon an in-flight indication of the primary engine FUEL FILTER light in addition to the A/F FUEL FILTER light, the pilot should land immediately to preclude engine stoppage in flight.

CAUTION

The pilot should be prepared for engine stoppage at any time during the landing approach.

SECTION V. PERFORMANCE

5-3-6. Same as Basic Flight Manual.

SECTION VI. WEIGHT AND BALANCE

5-3-7. A new weight and balance should be recalculated per the instructions in section 6 of the Basic Flight Manual using the information listed below.

	Weight (lbs)	Arm (in)	Moment (in-lbs)
External Fuel Filter Kit	6.24*	132.8	828.7

* This includes the additional .2 gallon of unusable fuel in the filter. Note that the useable fuel capacity of the aircraft does not change.

TABLE OF CONTENTS

SUPPLEMENT NUMBER 4

BAGGAGE BOX EXTENSION

SECTION I. GENERAL

5-4-1. Introduction This supplement must be attached to the Basic Flight Manual when the Enstrom Baggage Box Extension Kit No. 4220029 is installed on the helicopter. Operation in compliance with Section 1, Operating Limitations, is mandatory except as modified by this supplement. Other approved sections and supplemental data are recommended procedures.

5-4-2. Description The baggage box extension comprises an additional floor from the end of the standard baggage box to the second tail cone former and fabric bulkhead at the aft end of the extension. It is separated from the standard baggage box by a removable fabric bulkhead. This bulkhead is also the main access to the baggage box extension. The extension was designed to contain bulky, relatively lightweight items which normally do not need to be removed or stowed each flight, such as survival gear. As such, both the capacity, which is determined primarily by the aircraft center of gravity, and the access are somewhat limited.

SECTION II. OPERATING LIMITATIONS

5-4-3. Maximum Capacity: 50 Pounds (22.7 kg). The aircraft Gross Weight (GW) and Center of Gravity (CG) MUST remain within the GW and CG limits specified in the basic flight manual (reference paragraph 1-12 and figures 4-7 and 6-4 of the basic flight manual).

CAUTION

The pilot in command is responsible for insuring that the center of gravity remains within the limits published for the aircraft. It is possible to exceed the center of gravity limits depending upon aircraft empty weight and the load carried.

SECTION III. NORMAL PROCEDURES

5-4-4. Add the following to the Exterior Check, Paragraph 2-11, "Aft Fuselage - Left Side - Area 2", Item 8 "Baggage compartment":

a. Check cargo is properly secured and weight is known.

b. Check security and condition of fabric bulkhead.

SECTION IV. EMERGENCY PROCEDURES

5-4-5. Same as Basic Flight Manual.

SECTION V. PERFORMANCE

5-4-6. Same as Basic Flight Manual.

SECTION VI. WEIGHT AND BALANCE

5-4-7. A new weight and balance should be recalculated per the instructions in section 6 of the Basic Flight Manual using the information listed below.

	Weight (lbs)	Arm (in)	Moment (in-lbs)
Baggage Box Extension Kit	3.2	216.5	692.8
Cargo in Extension Area	XX	216.5	(XX)x215

NOTE

Operation with a solo pilot may require additional ballast to be secured in either the right front seat or footwell to offset the weight in the extended baggage box.

TABLE OF CONTENTS

SUPPLEMENT NUMBER 5

CAMERA DOOR

SECTION I. GENERAL

5-5-1. Introduction

This supplement must be attached to the Basic Flight Manual when the Enstrom Camera Door Kit No. 4220079 is installed on the aircraft. Operation in compliance with Chapter 1, Operating Limitations, of the Basic Flight Manual is mandatory except as modified by this supplement. Other approved sections and supplemental data are recommended procedures.

5-5-2. Description

The camera door, part number 4220079, provides a large vertical sliding window in the right door of the aircraft. This window is intended to allow an observer enough room to use a camera without interference from the plexiglass window. The window may be opened or closed in flight as desired.

SECTION II. OPERATING LIMITATIONS

5-5-3. General

The left cabin door must be installed anytime the camera door is installed on the right side of the aircraft.

5-5-4. Airspeed Limits

When the camera door is installed, the V_{ne} is the lessor of 100 knots or the speed defined in Figure 1-3 of the Basic Flight Manual. This applies with the window open or closed.

5-5-5. Placards

The following placard must be installed near the existing V_{ne} placards above the main windshield:

V_{ne} IS THE LOWER OF 100 KTS OR AS SHOWN IN RFM FIGURE 1-3
WHEN THE CAMERA DOOR IS INSTALLED

SECTION III. NORMAL PROCEDURES

5-5-6. Preflight Check

The following shall be added to the Exterior Check (paragraphs 2-10 and 2-15 of the Basic Flight Manual)

a. Check camera door for condition and security of attachment.

b. Check camera window condition and security of attachment.

c. Check left cabin door for condition and security of attachment. Left cabin door is required when camera door is installed.

SECTION IV. EMERGENCY PROCEDURES

5-5-7. General

Same as Basic Flight Manual

SECTION V. PERFORMANCE

5-5-8. General

Same as Basic Flight Manual

SECTION VI. WEIGHT AND BALANCE

5-5-9. General

A new weight and balance should be recalculated per the instructions in Section 6 of the Basic Flight Manual using the information below:

ITEM	WEIGHT (lb)	ARM (in)	MOMENT (in-lb)
Additional Weight of Camera Door	1.0	100	100

TABLE OF CONTENTS

List of Figures

SUPPLEMENT NUMBER 6

INCREASED ROTOR SPEED AND TORQUE LIMITS

SECTION I. GENERAL

5-6-1. Introduction

This supplement must be attached to the Basic Flight Manual when the Increased Rotor Speed Kit No. 4230002 is installed on the aircraft. Operation in compliance with Chapter 1, Operating Limitations, of the Basic Flight Manual is mandatory except as modified by this supplement. Other approved sections and supplemental data are recommended procedures.

5-6-2. Description

The Increased Rotor Speed Kit, part number 4230002, incorporates a larger diameter lower pulley, P/N 4130510-19, into the basic aircraft. This changes the nominal power-on operating range from 356-365 RPM to 365-372 RPM and changes the maximum continuous torque to 63 PSI and the maximum take off torque to 68 PSI. It does not change the engine RPM limits (neither N_1 nor N_2). It does not change the autorotation RPM limits. It allows some changes in V_{ne} and in performance, as shown in this supplement.

SECTION II. OPERATING LIMITATIONS

5-6-3. General

This increased rotor RPM kit shall only be installed on aircraft equipped with the Enstrom P/N 28-13106-3 main rotor ring gear carrier. In addition, this kit also requires the P/N 4129100-3 oil cooling system installation.

5-6-4 Instrument Markings

The dual rotor/turbine tachometer, torquemeter, and airspeed indicator are shown in figure 5-6-1. Although the red and green markings on the dual rotor/turbine tachometer have not changed, the rotor and turbine scales are aligned slightly differently to allow the rotor and turbine indicator needles to marry properly.

5-6-5 Transmission Limits

The main transmission is subject to the limits shown in figure 5-6-2. Operating time above the maximum continuous limit of 63 PSI, in the range of 63 - 68 PSI, is limited to 5 minutes duration.

WARNING

Aircraft operating limits are based on the transmission torque limits and not the engine torque limits.

5-6-6 Engine Limits

a. Takeoff Power. Takeoff power is the maximum power permitted and is limited to a period of 5 minutes. Takeoff power is defined by a combination of torque and power turbine speed (N_2) but may be limited by turbine outlet temperature (TOT) in hot or high altitude conditions. The takeoff power limits are:

Torque.........68 PSI
N_2...............103%
TOT...........810°C

b. Maximum Continuous Power. Maximum continuous power is the maximum power permitted for continuous operation. Maximum continuous power is defined by a combination of torque and power turbine speed (N_2) but may be limited by turbine outlet temperature (TOT) in hot or high altitude conditions. The maximum continuous power limits are:

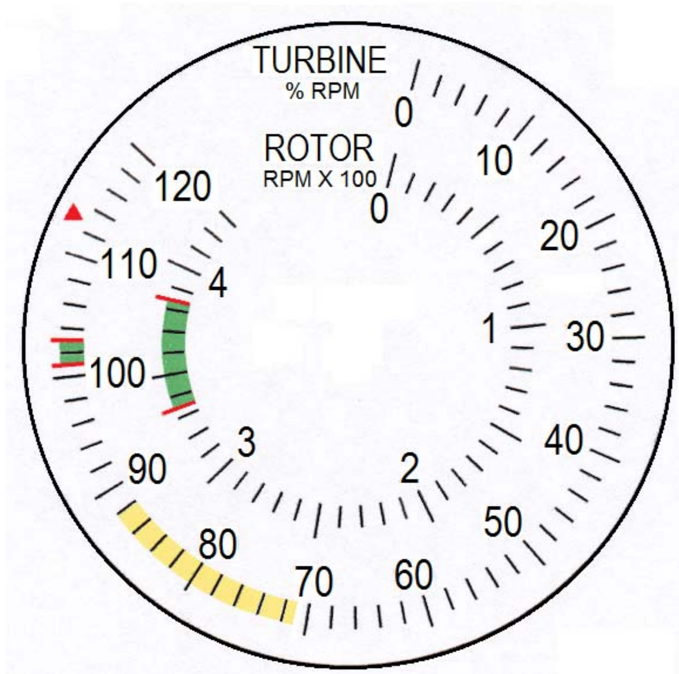
Torque.........63 PSI
N_2...............103%
TOT...........737°C

5-6-7 Airspeed Limits

The airspeed limits are shown in figure 5-6-3. Autorotations are limited to 85 knots or the power on V_{ne}, whichever is less. Figure 5-6-4 shows the weight vs. CG envelope with the individual V_{ne} envelopes labeled. The weight vs CG envelope has not changed from the Basic Flight Manual, however the relationship with the V_{ne} limits has changed somewhat.

5-6-8 Environmental Limits

Ambient Temperature. The maximum operational temperature is 48°C (118°F). The minimum operational ambient temperature is -32°C (-25°F).

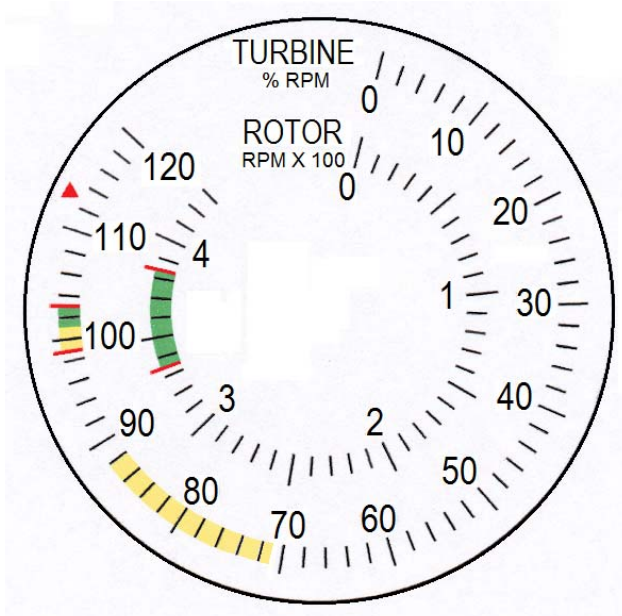


DUAL ROTOR AND POWER TURBINE TACHOMETER

ROTOR		
385 RPM	Red Radial	Maximum Power OFF
334-385 RPM	Green Arc	Continuous Operation (Including Autorotation)
334 RPM	Red Radial	Minimum Power OFF

POWER TURBINE (N_2)		
113% RPM	Red Arrowhead	15 Second Maximum Transient N_2 Varies Linearly from 113% in Autorotation per Figure 1-2.
103% RPM	Red Radial	Maximum N_2 Continuous
101-103% RPM	Green Arc	Normal Operating Range
101% RPM	Red Radial	Minimum N_2 Continuous
71-88 % RPM	Yellow Arc	Speed avoid range. Move through range as expediently as possible.

FIGURE 5-6-1. INSTRUMENT MARKINGS (Sheet 1 of 3)

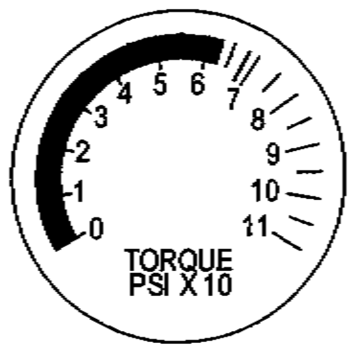


DUAL ROTOR AND POWER TURBINE TACHOMETER

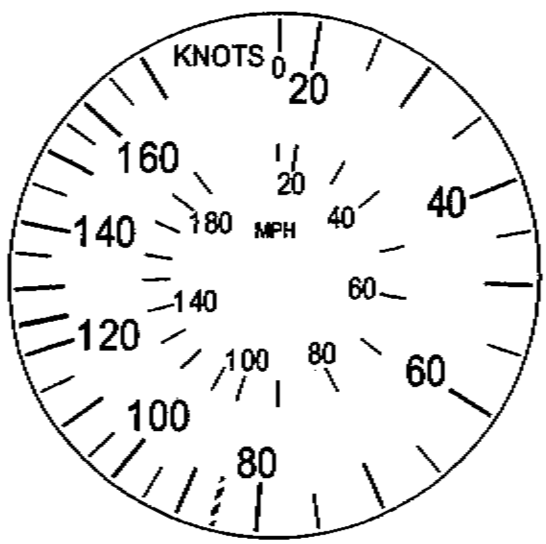
ROTOR		
385 RPM	Red Radial	Maximum Power OFF
334-385 RPM	Green Arc	Continuous Operation (Including Autorotation)
334 RPM	Red Radial	Minimum Power OFF

POWER TURBINE (N_2)		
113% RPM	Red Arrowhead	15 Second Maximum Transient N_2 Varies Linearly from 113% in Autorotation per Figure 5-6-2.
103% RPM	Red Radial	Maximum N_2 Continuous
101-103% RPM	Green Arc	Limited Operations in certain Loading Conditions with Emergency Pop-out Floats Installed. See supplement for emergency floats (supplement #8).
101% RPM	Red Radial	Minimum N_2 Continuous
71-88 % RPM	Yellow Arc	Speed avoid range. Move through range as expediently as possible.

FIGURE 5-6-1. INSTRUMENT MARKINGS (Sheet 2 of 3)



TORQUEMETER		
68 PSI	Red Radial	Maximum for Takeoff
63-68 PSI	Yellow Arc	5 minute limit
0-63 PSI	Green Arc	Continuous Operation



AIRSPEED INDICATOR		
125 kts	Red Radial	Maximum Power On V_{NE}
85 kts	Red Cross-Hatched Radial	Maximum Autorotation V_{NE}

FIGURE 5-6-1. INSTRUMENT MARKINGS (Sheet 3 of 3)

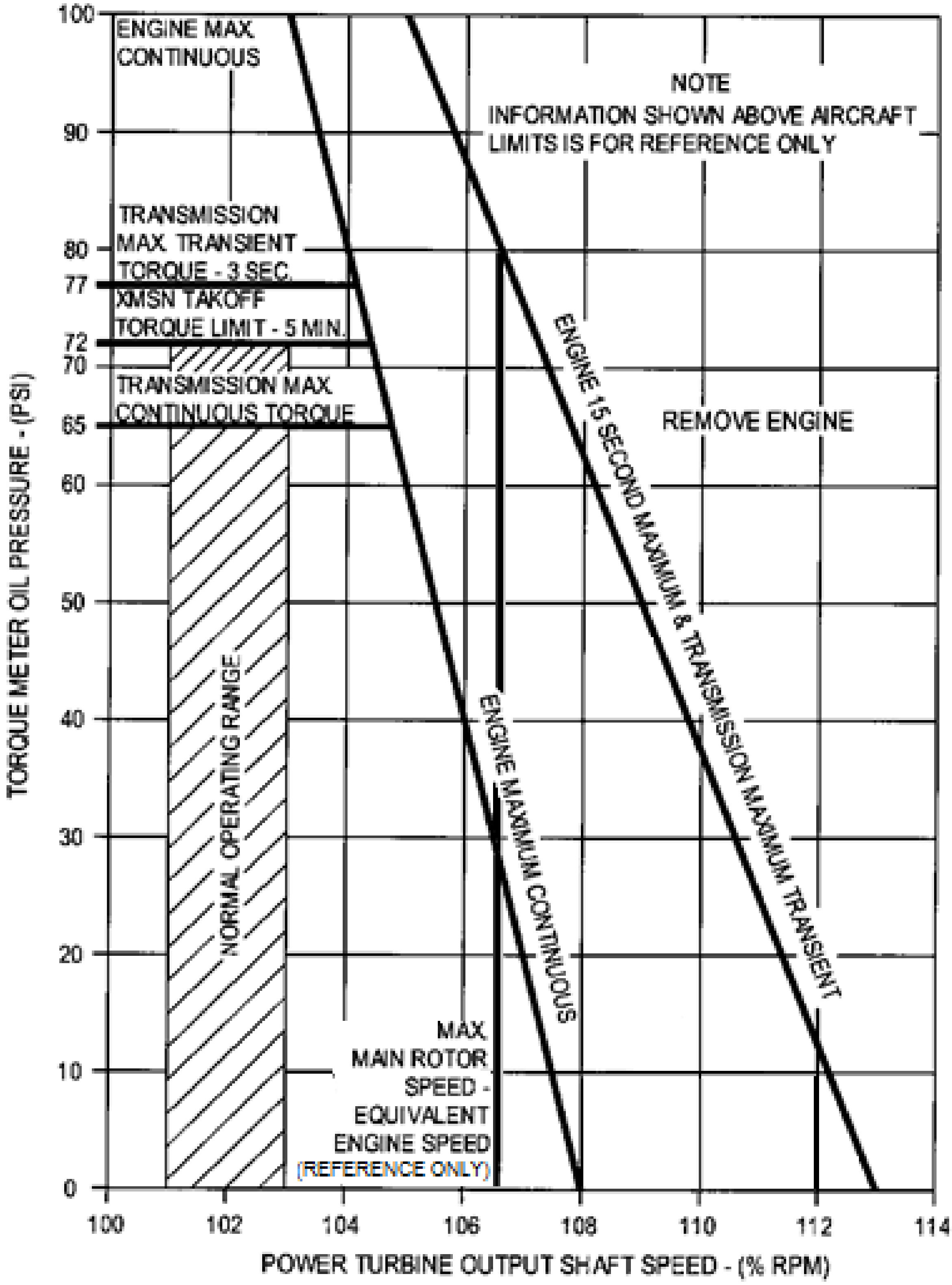


FIGURE 5-6-2. MAXIMUM ALLOWABLE TORQUE AND N2

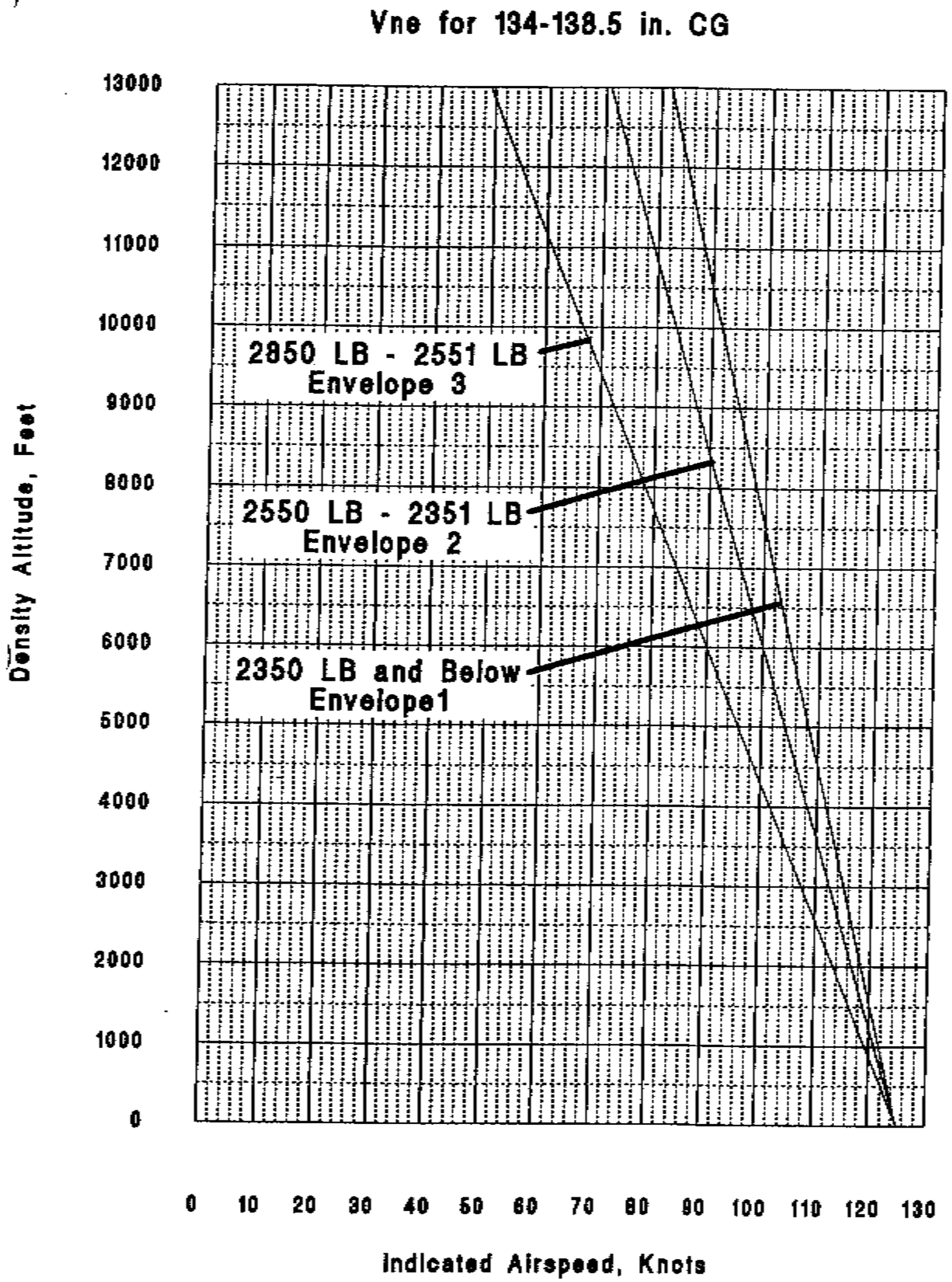


Figure 5-6-3. Airspeed Operating Limits (Sheet 1 of 3)

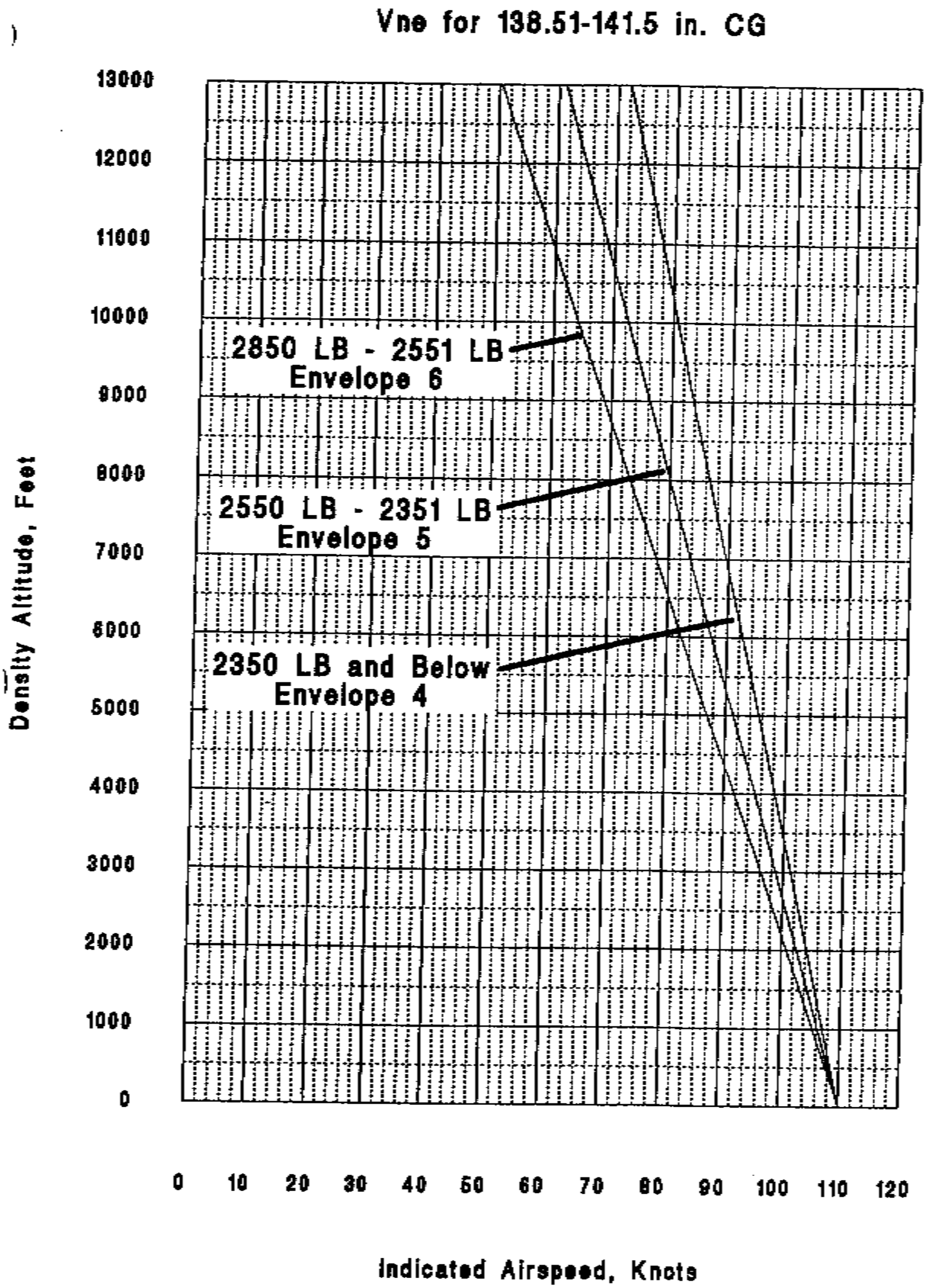


Figure 5-6-3. Airspeed Operating Limits (Sheet 2 of 3)

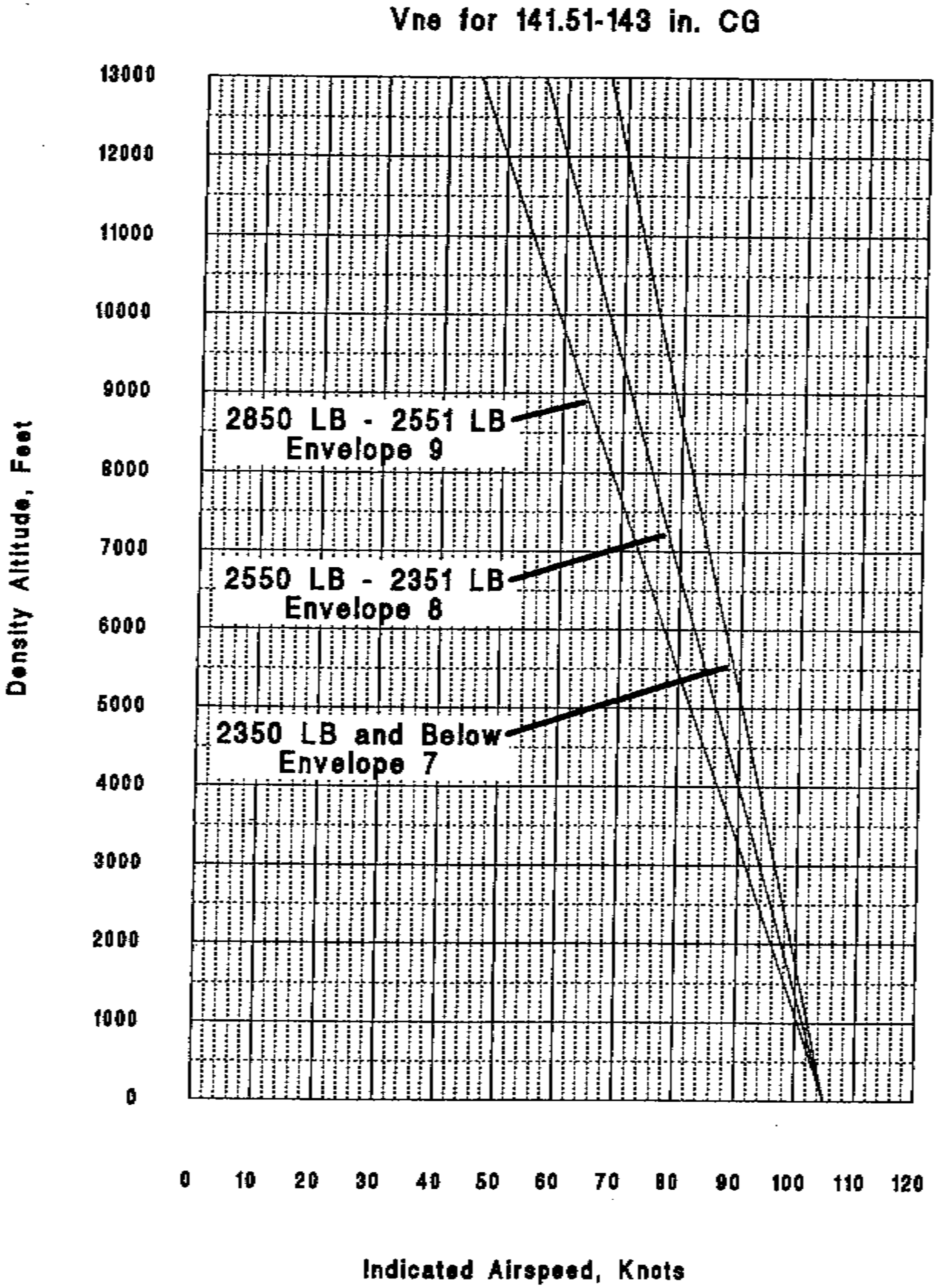


Figure 5-6-3. Airspeed Operating Limits (Sheet 3 of 3)

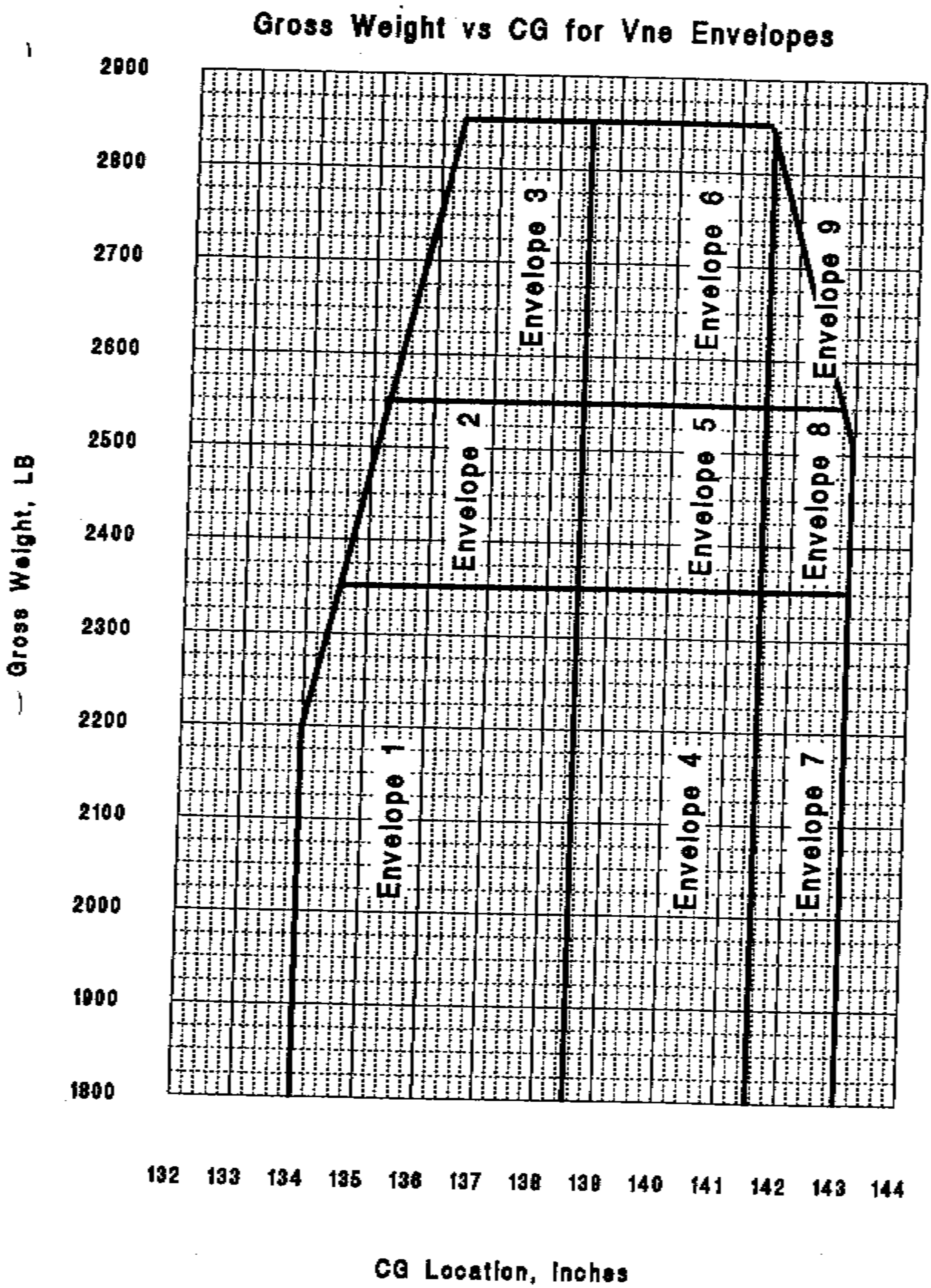
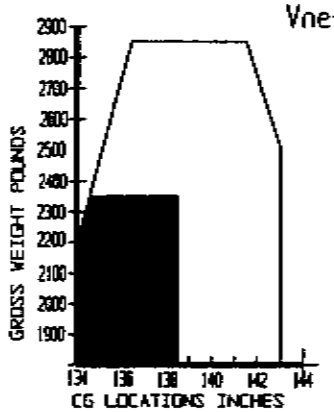


Figure 5-6-4. V_{ne}-CG-Gross Weight Envelope

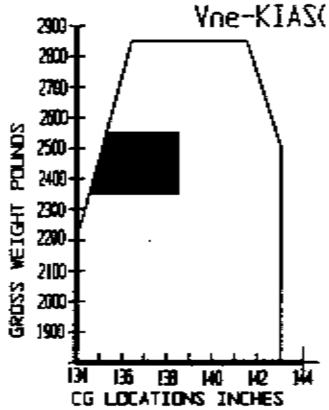
5-6-9 Placards

The following placards must be installed in place of the original V_{ne} placards:



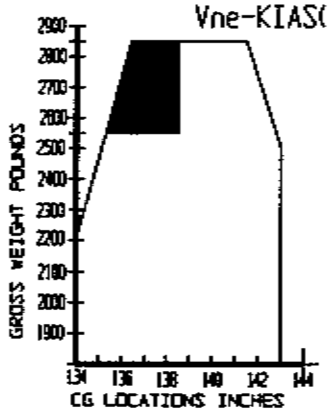
Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT UP TO 2350 LBS C.G. AS SHOWN

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	125	125	125	125	125	125	120	116	112
2000	125	125	125	125	121	117	112	108	104
4000	125	125	122	117	113	108	104	100	97
6000	121	119	114	109	104	100	96	92	89
8000	113	110	105	101	96	92	88	84	
10000	104	102	97	92	88	84			
12000	96	93	89	84					
14000	87	85							



Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT 2350 LBS TO 2550 LBS C.G. AS SHOWN

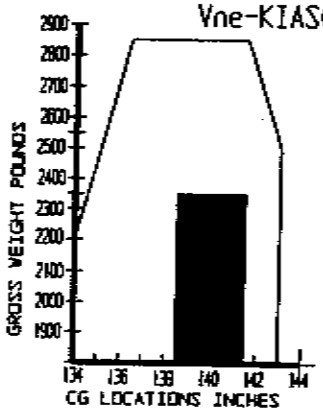
PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	125	125	125	125	125	125	119	114	109
2000	125	125	125	125	120	114	109	104	99
4000	125	125	121	115	110	104	99	94	89
6000	120	117	111	105	99	94	89	84	79
8000	110	106	100	95	89	84	79	74	
10000	99	96	90	84	79	74			
12000	89	85	80	74					
14000	78	75							



Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT 2550 LBS TO 2850 LBS C.G. AS SHOWN

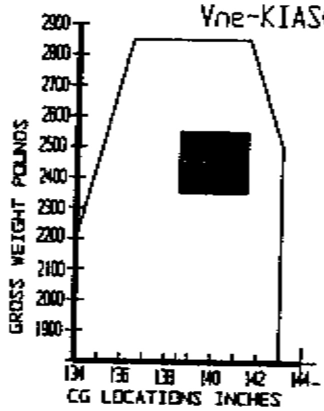
PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	125	125	125	125	125	125	117	110	103
2000	125	125	125	125	118	110	103	96	89
4000	125	125	120	111	103	96	89	82	75
6000	118	114	105	97	89	82	75	68	61
8000	104	99	91	82	75	67	60	54	
10000	89	84	76	68	60	53			
12000	74	70	61	54					
14000	59	55							

Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT TO 2350 LBS C.G. AS SHOWN



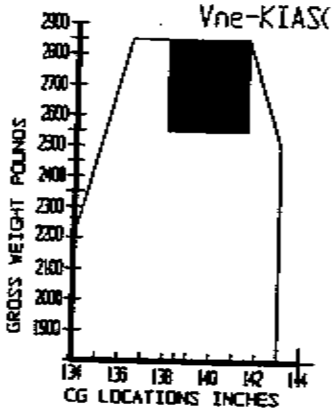
PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	110	110	110	110	110	110	106	102	99
2000	110	110	110	110	106	103	99	95	92
4000	110	110	107	103	99	95	92	88	85
6000	107	104	100	96	92	88	85	81	78
8000	99	97	93	89	85	81	78	74	
10000	92	90	85	81	78	74			
12000	84	82	78	74					
14000	77	75							

Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT 2350 LBS TO 2550 LBS C.G. AS SHOWN

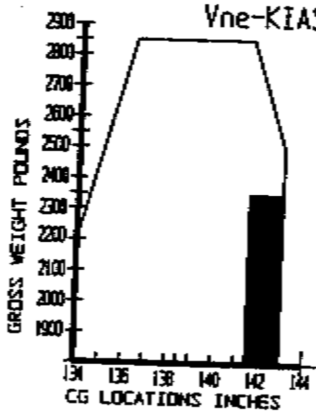


PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	110	110	110	110	110	110	105	100	96
2000	110	110	110	110	105	101	96	91	87
4000	110	110	107	101	96	91	87	82	78
6000	106	103	97	92	87	82	78	73	69
8000	96	93	88	83	78	73	68	64	
10000	87	84	78	73	68	64			
12000	77	74	69	64					
14000	68	65							

Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT 2550 LBS TO 2850 LBS C.G. AS SHOWN

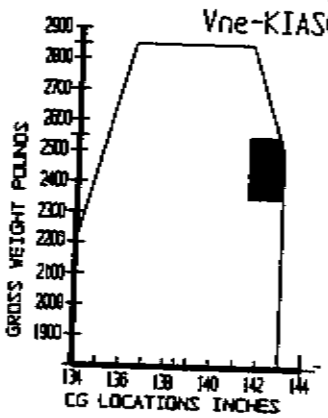


PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	110	110	110	110	110	110	104	98	93
2000	110	110	110	110	104	98	93	87	82
4000	110	110	106	99	93	87	81	76	71
6000	105	101	94	88	82	76	70	65	60
8000	93	90	83	77	70	65	59	54	
10000	81	78	71	65	59	54			
12000	70	66	60	54					
14000	58	55							



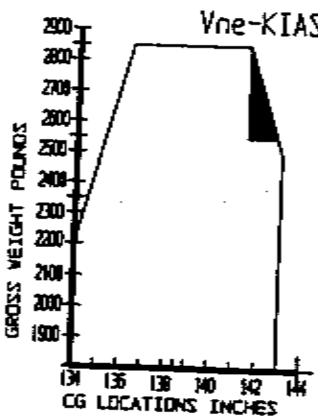
Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT TO 2350 LBS C.G. AS SHOWN

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	105	105	105	105	105	105	101	97	94
2000	105	105	105	105	101	98	94	90	87
4000	105	105	102	98	94	90	87	83	80
6000	102	99	95	91	87	83	80	76	73
8000	94	92	88	84	80	76	73	69	
10000	87	85	80	76	73	69			
12000	79	77	73	69					
14000	72	70							



Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT 2350 LBS TO 2550 LBS C.G. AS SHOWN

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	105	105	105	105	105	105	100	95	91
2000	105	105	105	105	100	96	91	86	82
4000	105	105	102	96	91	86	82	77	73
6000	101	98	92	87	82	77	73	68	64
8000	91	88	83	78	73	68	63	59	
10000	82	79	73	68	63	59			
12000	72	69	64	59					
14000	63	60							



Vne-KIAS(KNOTS) TAKE OFF GROSS WEIGHT 2550 LBS TO 2850 LBS C.G. AS SHOWN

PRESSURE ALTITUDE	OUTSIDE AIR TEMPERATURE °C °F								
°C	-34.5	-29.0	-18.0	-6.5	4.5	15.5	26.5	38.0	49.0
°F	-30	-20	0	20	40	60	80	100	120
SEA LEVEL	105	105	105	105	105	105	99	93	88
2000	105	105	105	101	99	93	88	82	77
4000	105	105	101	94	88	82	76	71	66
6000	100	96	89	83	77	71	65	60	55
8000	88	85	78	72	65	60	54	49	
10000	76	73	66	60	54	49			
12000	65	61	55	49					
14000	53	50							

SECTION III. NORMAL PROCEDURES

5-6-10. General

Same as Basic Flight Manual.

SECTION IV. EMERGENCY PROCEDURES

5-6-11. General

Same as Basic Flight Manual.

SECTION V. PERFORMANCE DATA

5-6-12. General

The increased rotor RPM and torque limits result in changes to the aircraft performance as shown in the following paragraphs. For any performance not covered below, refer to Chapter 4 of the Basic Flight Manual.

5-6-13 Torque Available

Figure 5-6-5 shows the effects of altitude and temperature on the available engine power. See paragraphs 4-16 through 4-17 of the Basic Flight Manual for cautions and further information.

5-6-14 Hover

Hover performance is shown in figure 5-6-6. This performance is based on 103% N_2 and 372 N_r, Jet A fuel, and 737 degrees C TOT, All bleed air off.

5-6-15 Power Assurance

The existing Engine Power Assurance Chart (Figure 4-10 of the Basic Flight Manual) is valid with the increased rotor RPM. Note that the "continuous xmsn limit" and "5 minute limit" lines are shown at 60 PSI and 67 PSI. With the increased RPM, these limits are 63 PSI and 68 PSI, respectively, rather than the lines shown.

5-6-16 Cruise

Cruise performance is shown in figures 5-6-7 through 5-6-10. These charts are used in the same manner as the charts in the Basic Flight Manual. These charts are based on 103% N_2, 372 N_r, and all bleed air off.

5-6-17 Climb

The Best Rate of Climb airspeed (V_y) is the same as presented in figure 4-13 of the Basic Flight Manual. The rate of climb can be determined by adding 125 feet per minute to the rates shown in figure 4-14 of the Basic Flight Manual.

5-6-18 Autorotation

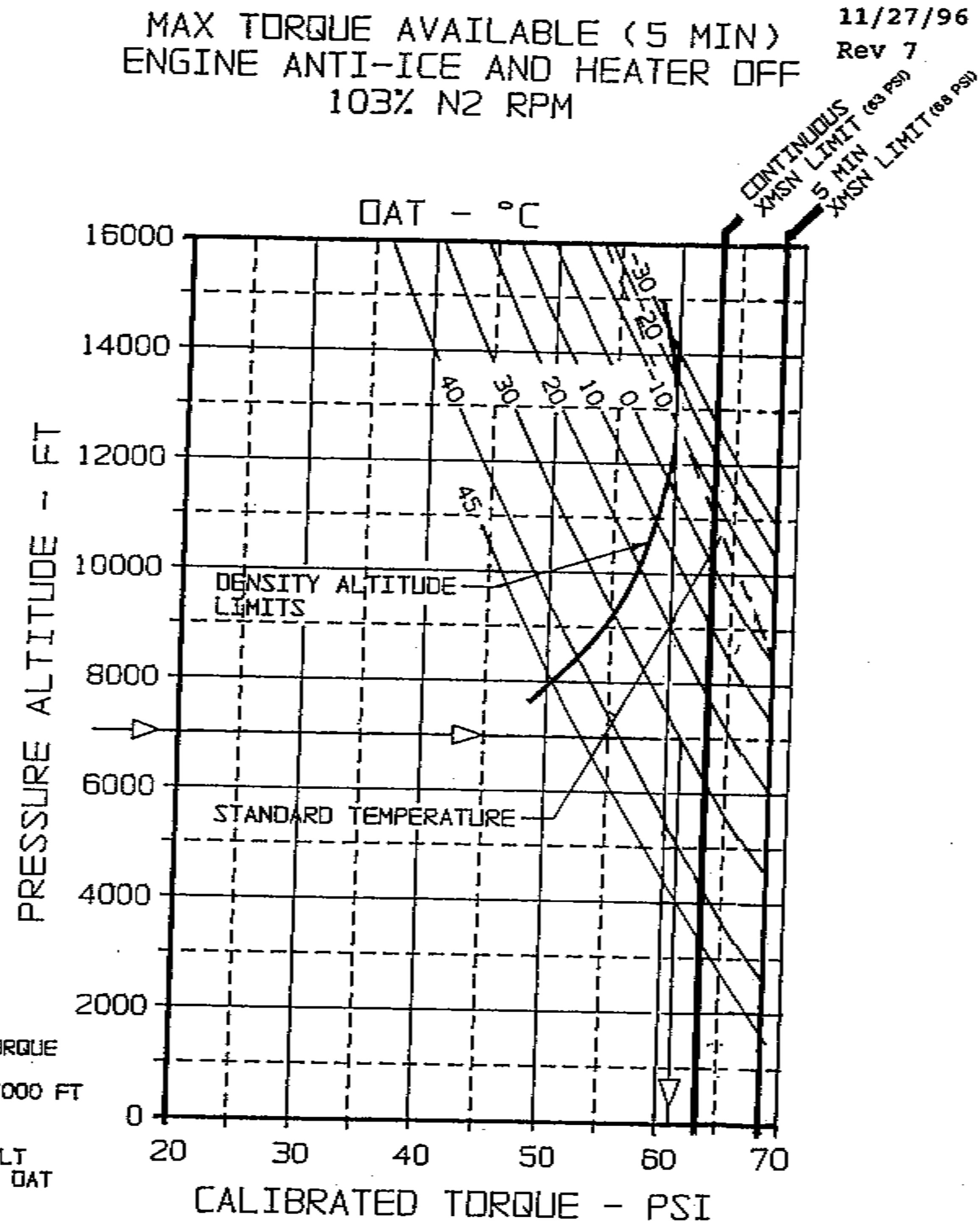
The data presented in the Basic Flight Manual is valid with the increased rotor RPM.

NOTE

The H-V Diagram (Figure 4-15) was demonstrated at minimum power-on RPM (365 N_R).

5-6-19 Noise

In accordance with Appendix J of FAR 36, the flyover sound exposure level at a reference airspeed of 99.5 KTAS is 83.6 dBA. No determination has been made by the Federal Aviation Administration that the noise levels of this aircraft are or should be acceptable or unacceptable for operation at, into, or out of any airport.



EXAMPLE:

WANTED
CALIBRATED TORQUE
KNOWN
PRESS ALT = 7000 FT
OAT = 30°C
METHOD
ENTER PRESS ALT
MOVE RIGHT TO OAT

DATA BASIS: CALCULATED FROM MODEL SPEC C965 22SEP89. CORRECTED FOR INSTALLATION LOSSES BASED ON FLIGHT TEST.

NOTE: AT COMBINATIONS OF ALTITUDE AND TEMPERATURE WHERE THE TRANSMISSION 5 MINUTE RATING IS NO LONGER THE LIMITING FACTOR, WITH ENGINE ANTI-ICE ON THE MAXIMUM TORQUE AVAILABLE MAY BE AS MUCH AS 9.8 PSI LOWER THAN CHART VALUE.

Figure 5-6-5. MAXIMUM TORQUE AVAILABLE (5 MINUTE LIMIT)

Calm Wind
103 % N2
372 Main Rotor RPM
All Bleed Air OFF

See Limitations section for Altitude and OAT limits

See Figure 4-7 for take off weight limitations

EXAMPLE:

5000 FT Pressure Altitude
10° C
2750 LB Gross Weight

56 PSI HIGE
64 PSI HOGE

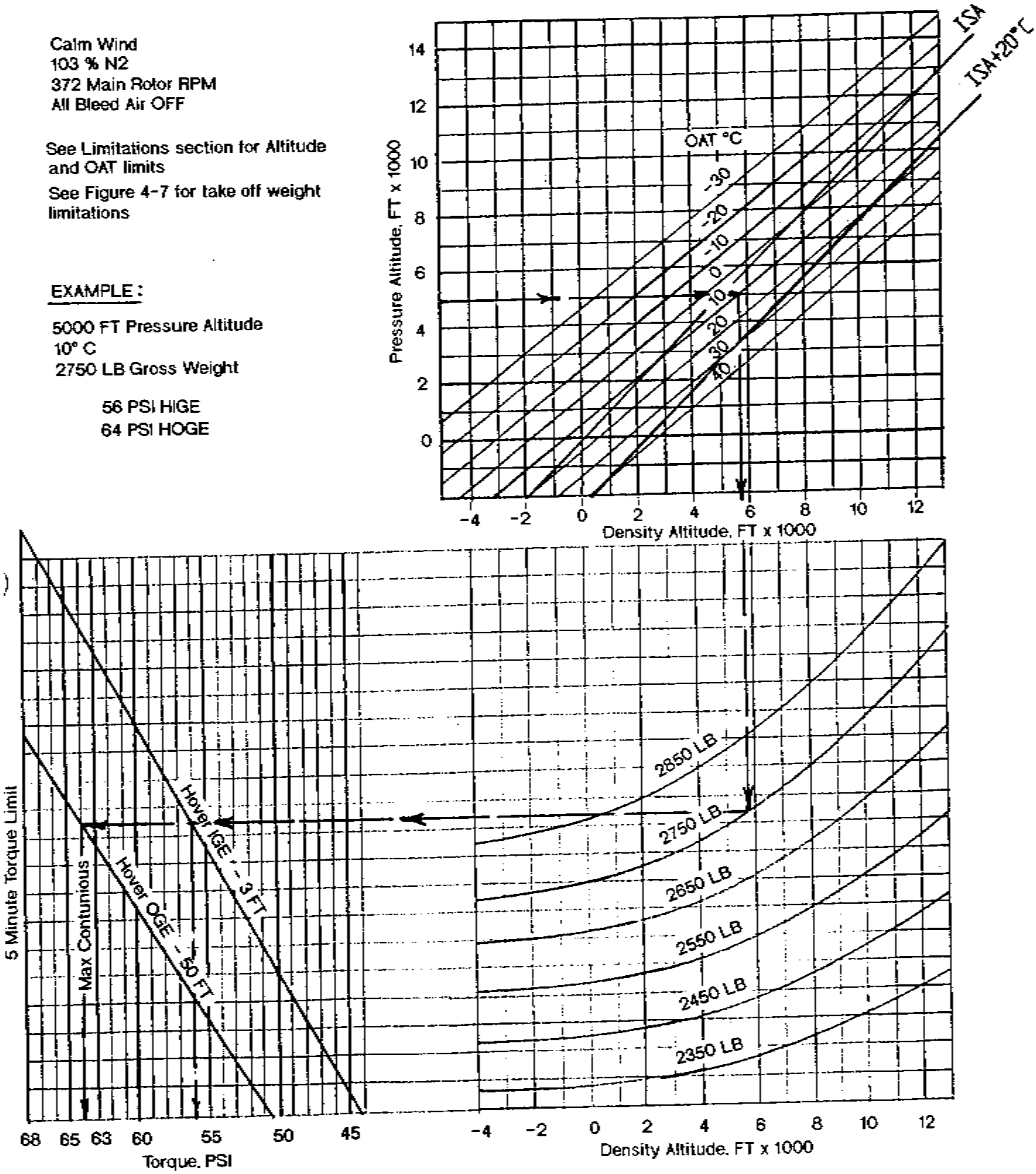


Figure 5-6-6. Hover Performance

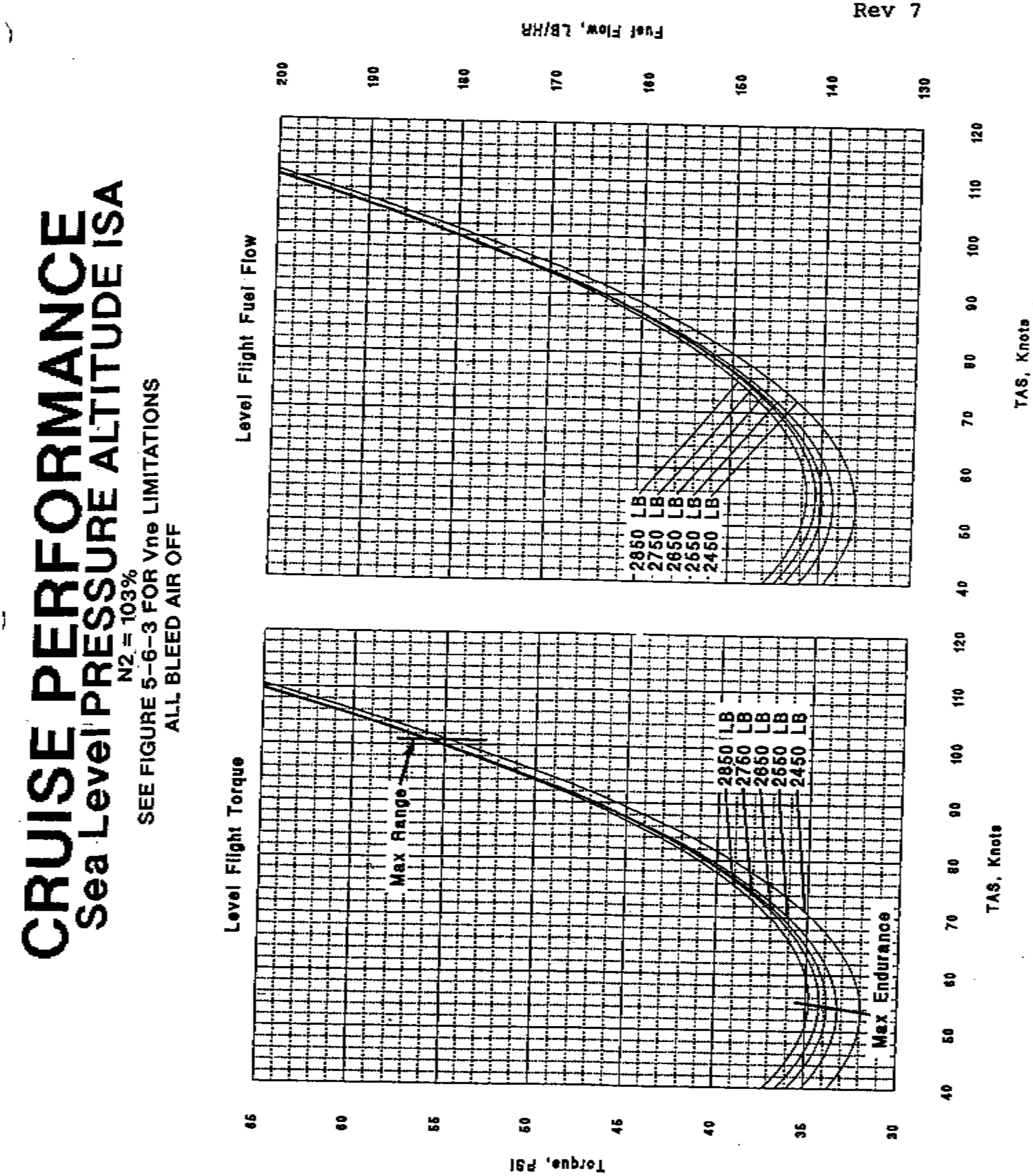


Figure 5-6-7. Cruise Performance at Sea Level

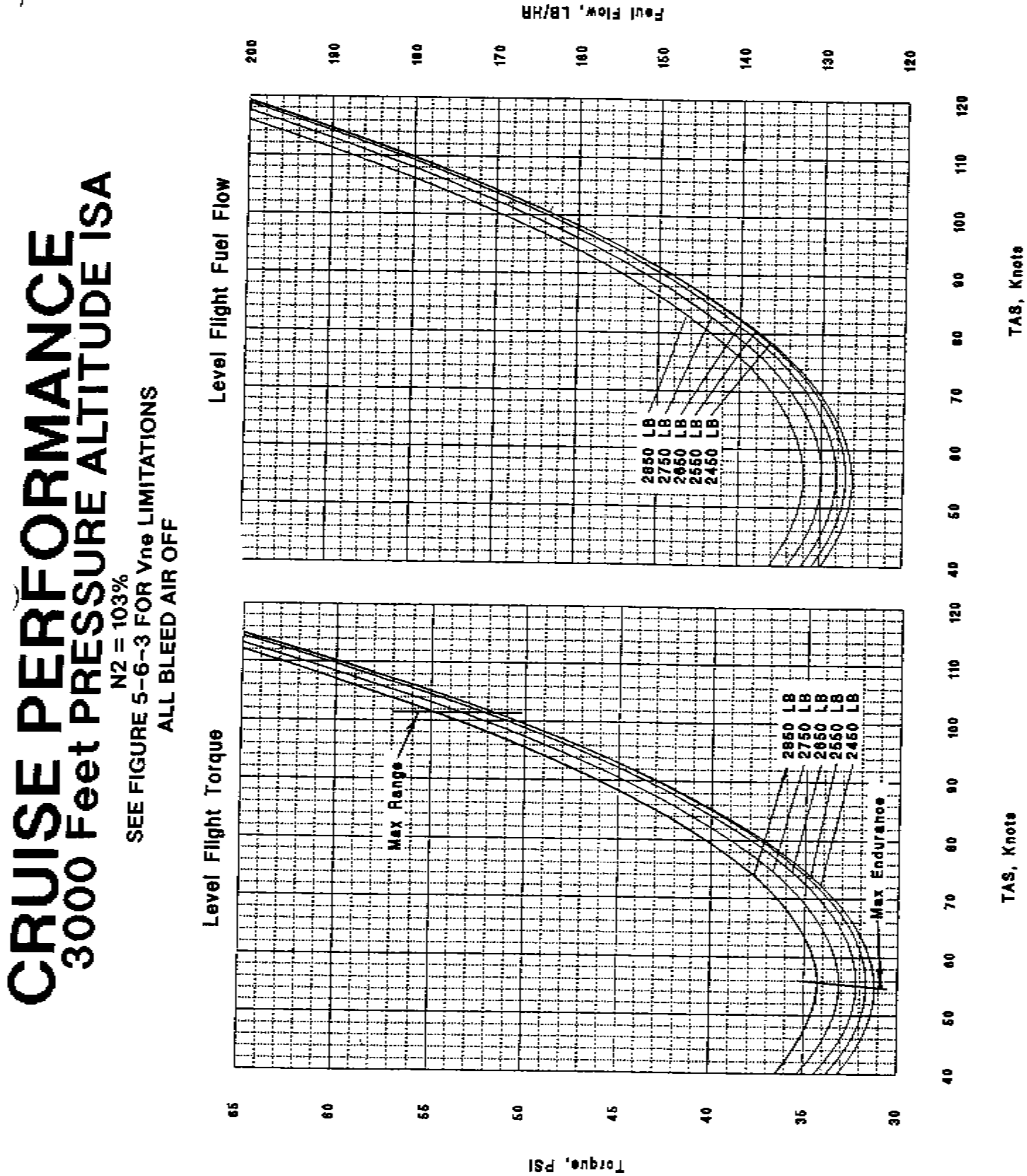


Figure 5-6-8. Cruise Performance at 3000 Feet

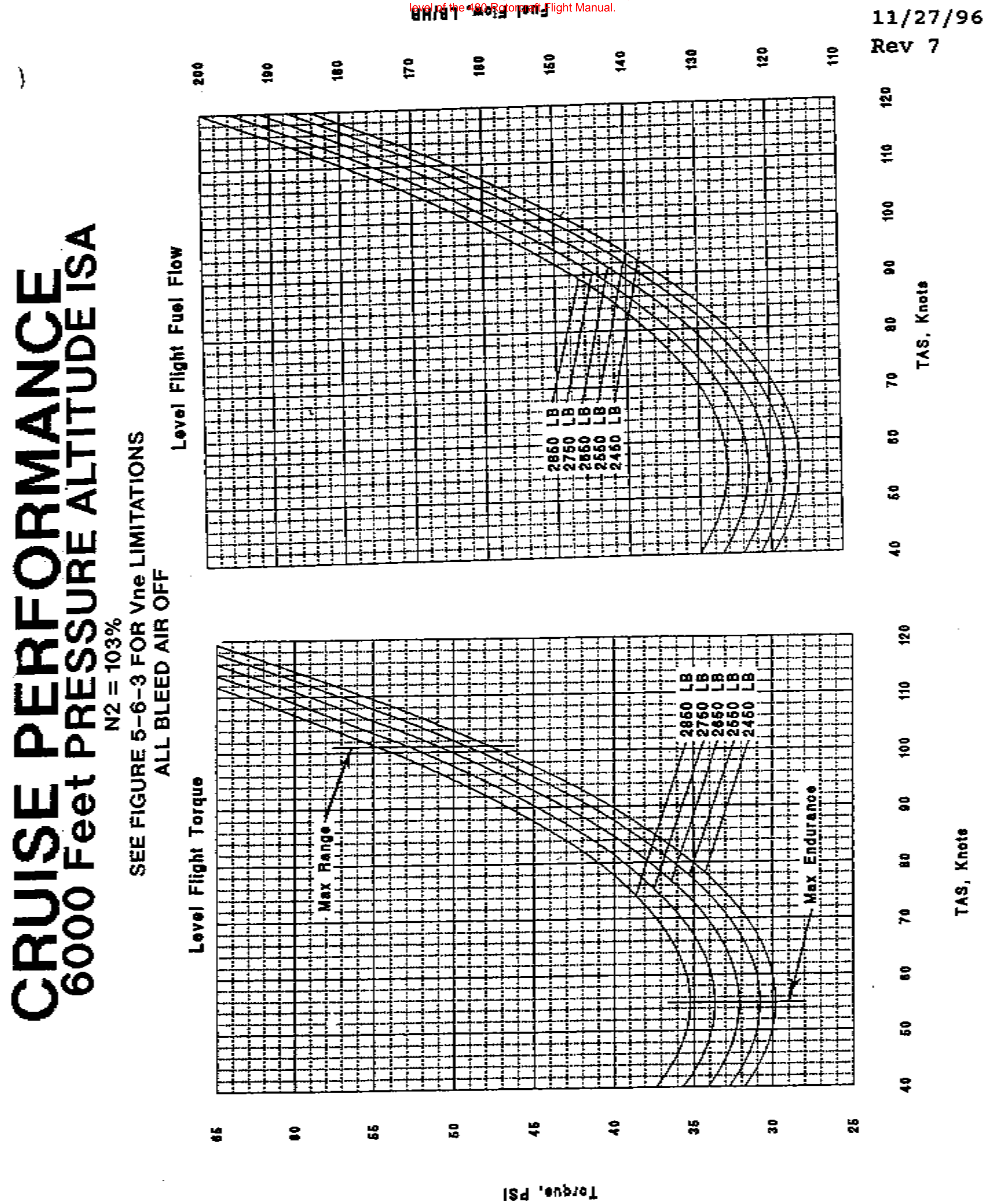


Figure 5-6-9. Cruise Performance at 6000 Feet

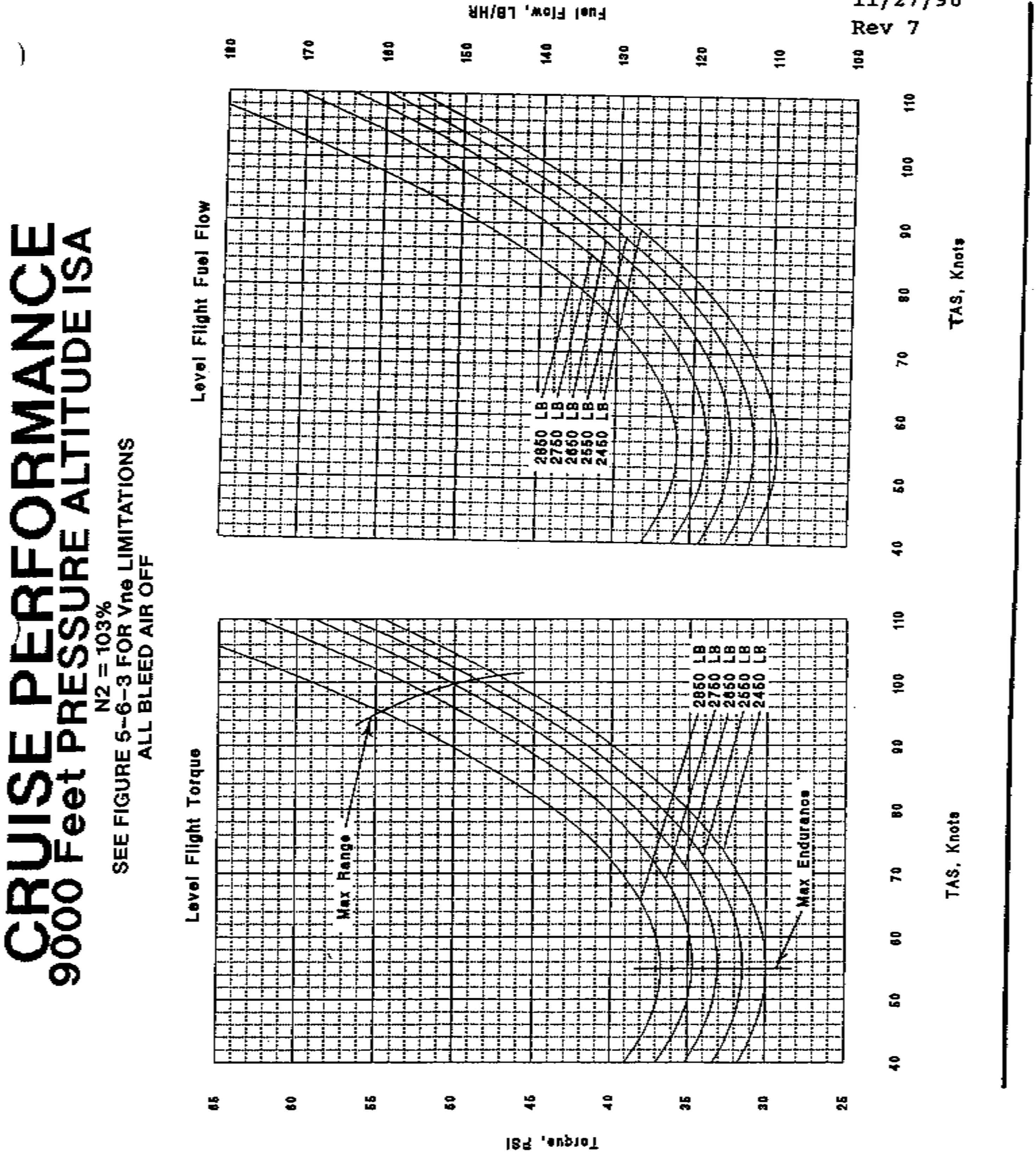


Figure 5-6-10. Cruise Performance at 9000 Feet

SECTION VI. WEIGHT AND BALANCE

5-6-20 General

Weight change is negligible.

Same as basic flight manual.

SUPPLEMENT 7

AIR CONDITIONING

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUPPLEMENT NUMBER 7

AIR CONDITIONING

SECTION I. GENERAL

5-7-1. Introduction

This supplement must be attached to the Basic Flight Manual when the Air Conditioner Option, as defined by Drawing Number 4220176, is installed on the aircraft. Operation in compliance with Chapter 1, Operating Limitations, of the Basic Flight Manual is mandatory except as modified by this supplement. Other approved sections and supplemental data are recommended procedures.

5-7-2. Description

The Air Conditioner, Part Number 4220176, is a vapor cycle system which consists of either two or three evaporator units in the cabin, a compressor which is belt driven off of the lower pulley assembly, and a condenser with an attached blower in the tailcone. The standard installation consists of two evaporator units mounted forward of the instrument console. Each evaporator unit has an integral heat exchanger and blower. As an option, a third evaporator unit may be installed on the cabin backwall behind the pilot's (left) seat. This evaporator is ducted to outlet vents at the top center of the cabin. The evaporators can be run either as coolers with the air conditioner running, or as blowers without the air conditioner running. The compressor is driven by a belt from the lower pulley assembly. The compressor has an electric clutch which engages and disengages the belt drive. The condenser is mounted in the tailcone. Air enters the tailcone through scoops on either side of the top of the condenser heat exchanger. The system uses R-134a (HFC-134a) refrigerant.

SECTION II. OPERATING LIMITATIONS

5-7-3. General

Same as Basic Flight Manual.

SECTION III. NORMAL PROCEDURES

5-7-4. Preflight Check

a. Add the following to the Before Exterior Check (Paragraph 2-9):

(1) Check evaporators and ducting for signs of refrigerant or oil leakage, condition, and security.

b. Add the following to the Aft Fuselage-Left Side-Area 2, Exterior Check (Paragraph 2-11):

(1) Check compressor and drive belt for condition, correct tension, and security.

(2) Check condenser lines for signs of refrigerant or oil leakage, condition, and security.

c. Add the following to the Tailcone-Left Side-Area 3, Exterior Check (Paragraph 2-12):

(1) Check condenser cooling air inlets for signs of debris. If signs are evident, loosen aft baggage box bulkhead curtain and inspect condenser cooling fan for additional signs of debris. Clean as required.

(2) Check condenser for signs of refrigerant or oil leakage, condition, and security at air exit located in bottom of the tailcone.

d. Add the following to the Tailcone-Right Side-Area 4, Exterior Check (Paragraph 2-13):

(1) Check condenser cooling air inlets for signs of debris. If signs are evident, loosen aft baggage box bulkhead curtain and inspect condenser cooling fan for additional signs of debris. Clean as required.

5-7-5. Before Starting Engine

a. Add the following to the Before Starting Engine (Paragraph 2-17):

(1) Air Conditioning - Prior to start, cycle air conditioner ON, listen for magnetic clutch engagement, turn OFF prior to start.

5-7-6. General Operation

a. If air conditioner is equipped with third evaporator, a separate blower switch is provided for back seat evaporator.

b. Individual air conditioner jets are located on either side on the main instrument console and in the overhead evaporator ducting for the back seat. These jets may be directed and opened or closed by the pilot and/or passengers.

5-7-7. In-Flight Operation

a. The air conditioning system may be turned ON or BLOWERS ONLY during ground run and engine warm up once the engine is at operating RPM (i.e., N_2 above 98%). Proper system operation will be indicated by an increase in engine torque of approximately 2 psi when the system is turned ON.

b. The air conditioning system may be operated in the ON or BLOWERS ONLY positions through out all phases of flight.

NOTE

The torque, TOT, and N_1 instrument indications will be higher than "normal" when the air conditioning system is ON.

5-7-8. Engine Shutdown

a. Add the following to the Engine Shutdown (Paragraph 2-37):

(1) Air Conditioning - Turn OFF or BLOWERS ONLY prior to reducing throttle to engine idle.

5-7-9. Air Conditioner Malfunctions

Lack of cooling may be an indication of an air conditioner malfunction. If the air coming out of the air conditioner vents is not cool within a reasonable amount of time after turning the air conditioner ON, turn the air conditioner OFF. The blowers may be operated with the air conditioner OFF if there is no indication that the blowers are malfunctioning.

5-7-10. Electrical System Failure

Turn the air conditioner and all evaporator blowers OFF with any sign of electrical failure (e.g., Caution Warning Panel - GEN OUT).

5-7-11. Compressor Lock-up

The oil for the compressor is carried by the refrigerant. Loss of refrigerant and oil can result in a compressor lock-up. Should this happen in flight, the fan belt will slip and deteriorate with a lot of smoke and noise. Turn the air conditioner and evaporator blowers OFF and land as soon as practicable to access any other damage prior to continuing flight.

SECTION V. PERFORMANCE

5-7-12. Torque Available

The torque available data shown on Figure 4-6 and Figure 5-6-5 of the approved rotorcraft flight manual does not change with the installation of the air conditioner system.

5-7-13. Take-off Performance

No change from the basic flight manual.

5-7-14. Hover Performance

a. When the air conditioner is ON, add 65 lbs to the actual gross weight of the aircraft and read the hover performance from the hover performance charts (Figure 4-9 or Figure 5-6-6) on pages 4-16 and 5-6-17 of the approved rotorcraft flight manual. Refer to the following paragraph for an example.

b. Assume the following conditions with the air conditioner OFF (Refer to Figure 4-9): 2,000 Ft pressure altitude, 30°C OAT, and 2,700 lbs aircraft gross weight. The HIGE power required is 53 PSI. When the air conditioner is turned ON, add 65 pounds to the actual aircraft gross weight (2,700 lbs + 65 lbs = 2,765 lbs) to compensate for the increase in power required because of the air conditioner. The HIGE power required is 55 PSI with the air conditioner ON.

5-7-15. Rate of Climb Performance

Reduce rate of climb shown on Figure 4-12 by 70 fpm for all conditions with the air conditioner system turned ON.

5-7-16. Cruise Performance

Cruise airspeed will be reduced by 2 kts for all gross weights shown on Figures 4-11.1, 4-11.2, and 4-11.3 of the approved rotorcraft flight manual and by 2 kts for all gross weights shown on Figures 5-6-7, 5-6-8, and 5-6-9 of Supplement 6 of the approved rotorcraft flight manual when the air conditioner is ON.

SECTION VI. WEIGHT AND BALANCE

5-7-17. General

A new weight and balance should be recalculated per the instructions in Section 6 of the approved rotorcraft flight manual using the following weight and moment arm information:

Table 5-7-1. Weight and Balance Information

Equipment	Weight (lbs)	Arm (in)	Moment (in-lbs)
Compressor with Clutch, Belt, and Installation Components	15	164.1	2461.5
Condenser with Cooling Fan	17	211.3	3592.1
Forward Evaporators	19.9	34.8	692.5
Forward Evaporator Support Structure	2.8	37.4	104.7
Aft Evaporator and Ducting (If installed)	12.8	115	1472
Line, Fittings, and Miscellaneous Equipment	19.7	148.4	2923.5
Total (2 Evaporators)	74.4	131.4	9774.3
Total (3 Evaporators)	87.2	129	11246.3

SECTION VII. SYSTEM DESCRIPTION

5-7-16. General

a. A simplified plumbing schematic of the air conditioning system is provided in Figure 5-7-1. This schematic shows all of the components and the direction of the refrigerant flow through the system. It also depicts the high pressure and low pressure service ports.

b. Operation of the air conditioning system is controlled by switches located in the lower center avionics panel. Figure 5-7-2 shows the switch and circuit breaker locations for the air conditioning system.

NOTE

The location of the switches and circuit breakers may be different than shown in Figure 5-7-2 depending on the customer specified avionics installed in the aircraft.

c. The system may be run with either the blowers on or the air conditioner on. When the air conditioner is on, the evaporator blowers are also on. The evaporator blowers may run at either high or low speed in either mode.

d. Figure 5-7-3 shows the location and function of the various air conditioning system components installed in the aircraft.

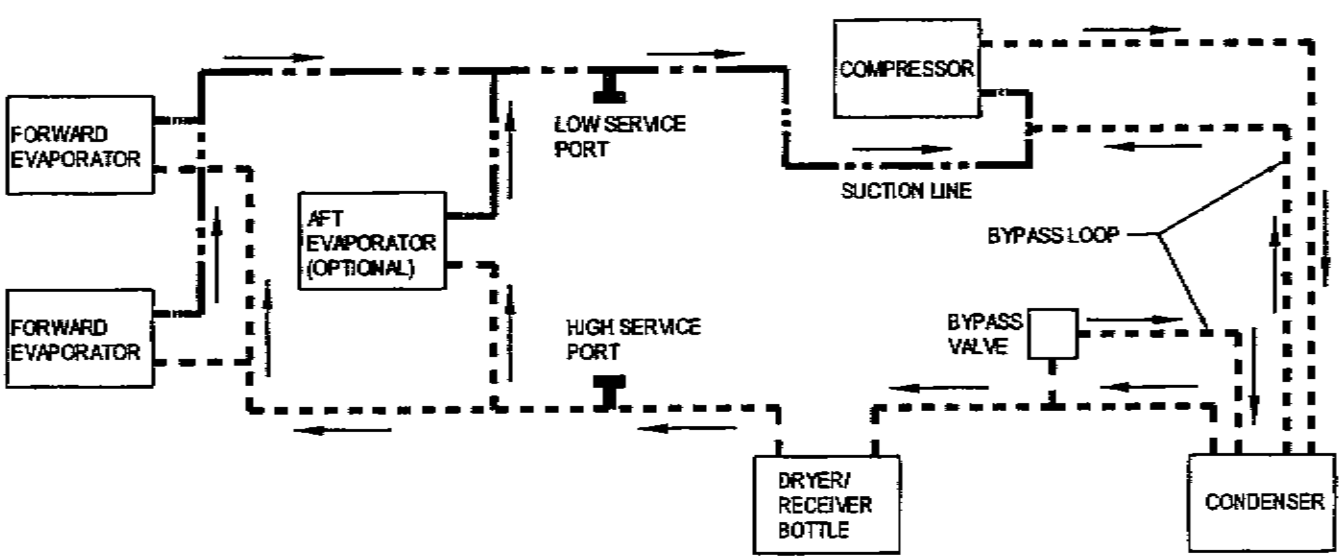
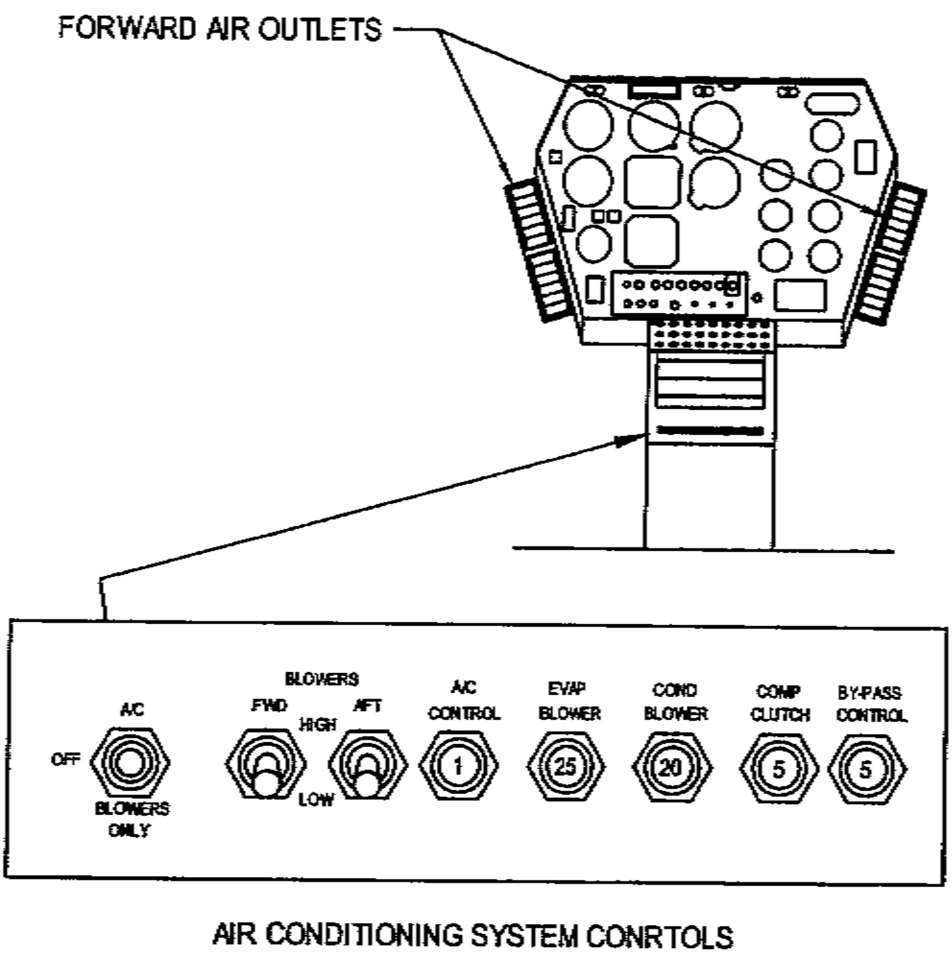
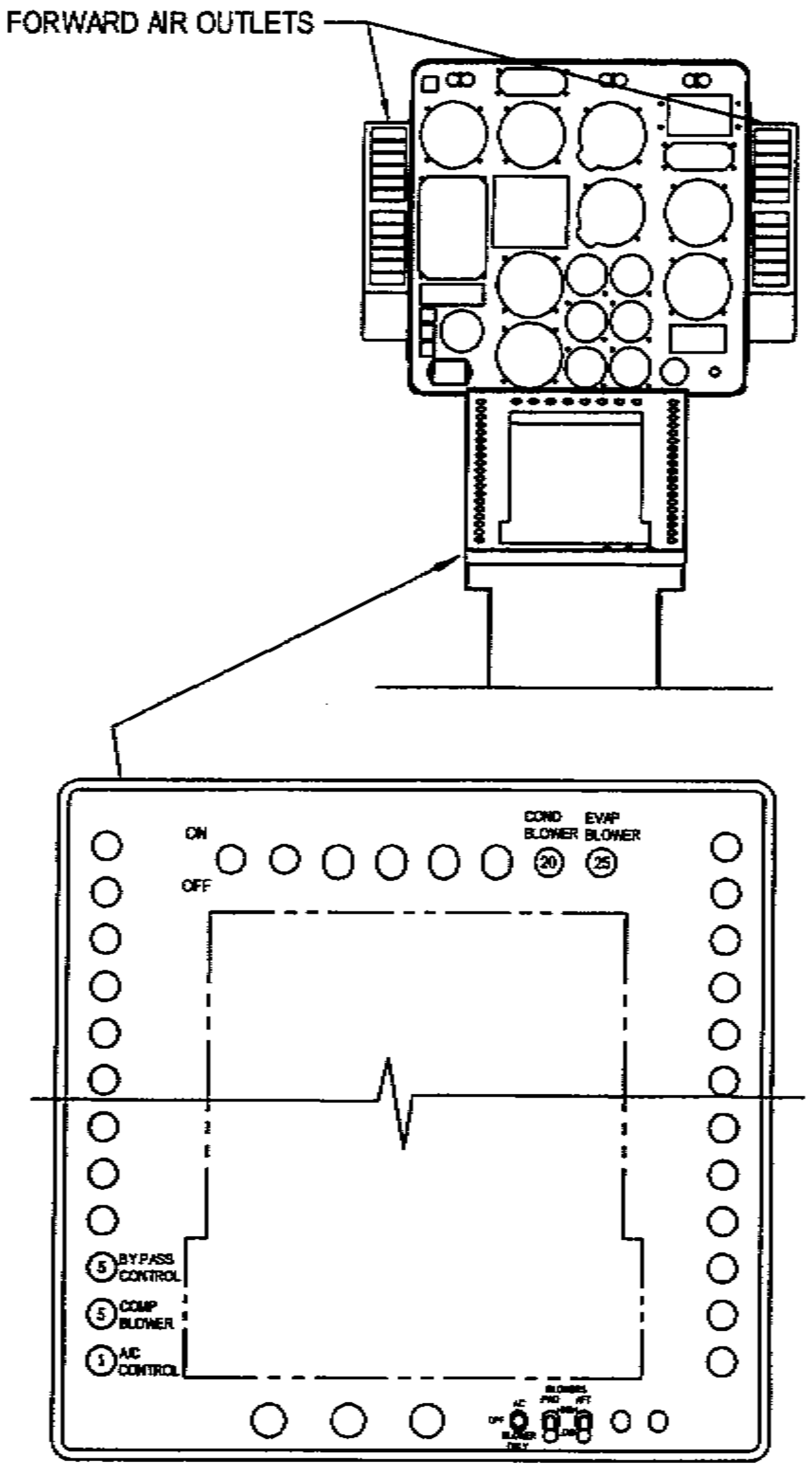


Figure 5-7-1. Air Conditioning System Schematic



Sheet 1 of 2

Figure 5-7-2. Air Conditioning Switch Panel



AIR CONDITIONING SYSTEM CONTROLS
(480 OPTIONAL PANEL)

Sheet 2 of 2

Figure 5-7-2. Air Conditioning Switch Panel

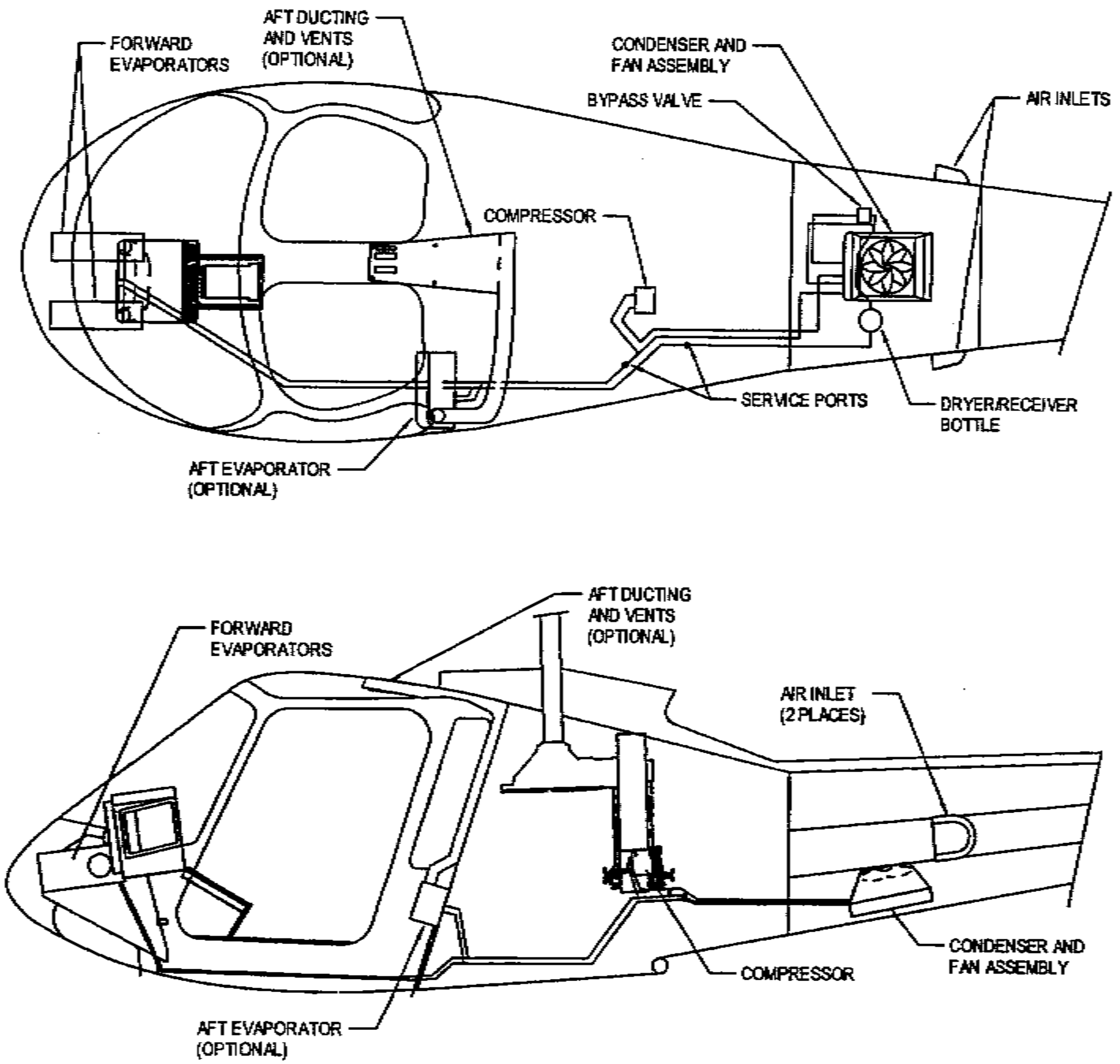


Figure 5-7-3. Air Conditioning System - General Arrangement

TABLE OF CONTENTS

LIST OF FIGURES

SUPPLEMENT NUMBER 8

EMERGENCY FLOATS

Section I. GENERAL

5-8-1. Introduction

This supplement must be attached to the Basic Flight Manual when the Emergency Float Kit, Number 4220091 is installed on the aircraft. Operation in compliance with Chapter 1, Operating Limitations, of the Basic Flight Manual is mandatory except as modified by this supplement. Other approved sections and supplemental data are recommended procedures.

5-8-2. Description

The emergency floats are designed to allow the aircraft to make a safe landing on water during an emergency situation. They are not designed for day-to-day operations involving take-offs and landings to the water and are not certified for take-offs from the water.

The Emergency Float Kit, part number 4220091, consists of six separate floats, three mounted on each landing gear skid, and a nitrogen cylinder mounted under the belly of the cabin. Each of the six floats has two separate compartments and is stowed, deflated, on top of the landing gear skid tube in its own container. The cylinder is discharged by pulling a handle mounted on the pilot's cyclic. This cylinder is plumbed to each of the individual floats and, when discharged, fully inflates them within 15 seconds.

Section II. OPERATING LIMITATIONS

5-8-3. General

Operations with the floats stowed must be conducted within the limitations of the basic Rotorcraft Flight Manual. Operations with the floats inflated are limited to emergency landings and a one-time ferry flight to a facility where the floats may be inspected and re-packed. During this ferry flight, which may include a take off from the water, the crew is limited to essential personnel only and the airspeed must be limited to the lower of 85 knots or the V_{NE} in the appropriate limitations section.

5-8-4. Airspeed Limits

The airspeed limitations are the same as those listed in the basic Rotorcraft Flight Manual with the floats stowed. The airspeed must be kept below 85 knots during float deployment and with the floats inflated.

5-8-5. Altitude Limits

Do not deploy the floats more than 4000 feet above the intended landing area.

5-8-6. Power On Operating Limits

The tachometer shall be marked as shown in Figure 1-1 (page 1-2) for the standard aircraft or as shown in Figure 5-6-1 (page 5-6-3.1) for aircraft equipped with the increased rotor RPM kit (reference supplement #6).

The normal power on operating range is 101-103% N_2. For aircraft equipped with the increased rotor RPM kit (reference supplement #6), this is 365-372 rotor RPM. These aircraft may be operated at N_2 speeds as low as 99% (357 rotor RPM) in hover and low speed flight to avoid unusual vibrations with light cabin loads and more than 500 pounds of fuel. See paragraph 5-8-9.

5-8-7. Placards

Installed above windshield:

Maximum airspeed 85 knots with floats inflated.

Section III. Normal Procedures

5-8-8. Preflight Check

Add the following to Before Exterior Check (Paragraph 2-9):

1. Inspect float inflation control handle (on pilot's cyclic) for condition and security.

Add the following to Aft Fuselage - Left Side - Area 2 (Paragraph 2-11):

1. Inspect floats assemblies for condition and security. Any damage to the covers is an indication of possible damage to the floats.

2. Inspect all visible hoses and lines for condition and security.

Add the following to Fuselage - Right Side - Area 5 (Paragraph 2-14):

1. Inspect floats assemblies for condition and security. Any damage to the covers is an indication of possible damage to the floats.

2. Inspect all visible hoses and lines for condition and security.

3. Inspect cylinder for condition and security. Check safety pin is removed. Check cylinder pressure is within ± 50 PSI (345 kPa) of the value listed in Figure 5-8-1.

5-8-9. Hover and Low Speed Flight

During hover and low speed flight under certain loading conditions with floats installed, aircraft equipped with the increased rotor RPM kit (reference supplement #6) may encounter high vibrations. These vibrations may be encountered when operating the aircraft above 101% N_2 with more than 500 pounds of fuel and light cabin loads (such as solo pilot). These vibrations normally do not occur with less than 500 pounds of fuel or with heavier cabin loads. In order to avoid these unusual vibrations, any time the aircraft is operated with light cabin loads and more than 500 pounds of fuel, all hover and slow speed flight, including the initial phase of the take off and the landing approach, should be conducted at 99% N_2 (357 rotor RPM). All other operations should be conducted at 101-103% N_2. See "Emergency Procedures" section of this supplement for further information.

5-8-10. Before Landing.

If the aircraft is equipped with the increased rotor RPM kit (reference supplement #6), add the following to the "Before Landing" check:

1. With light cabin loads (solo pilot) and more than 500 pounds of fuel, N_2 - 99%.

2. With heavy cabin loads or less than 500 pounds of fuel, N_2 - 101-103%.

5-8-11. Ferry for Repacking.

1. Make sure that the situation which caused the emergency has been corrected.

2. Make sure that the aircraft is safe to fly. Pay special attention to the tail rotor and tail rotor drive systems for signs of strikes.

3. For the ferry flight, personnel on board the aircraft is limited to essential crew only.

4. Maintain airspeed below 85 knots IAS or the appropriate V_{NE}, whichever is lower.

NOTE: Servicable pressure range is ± 50 psig (345 kPa) for corresponding ambient temperature

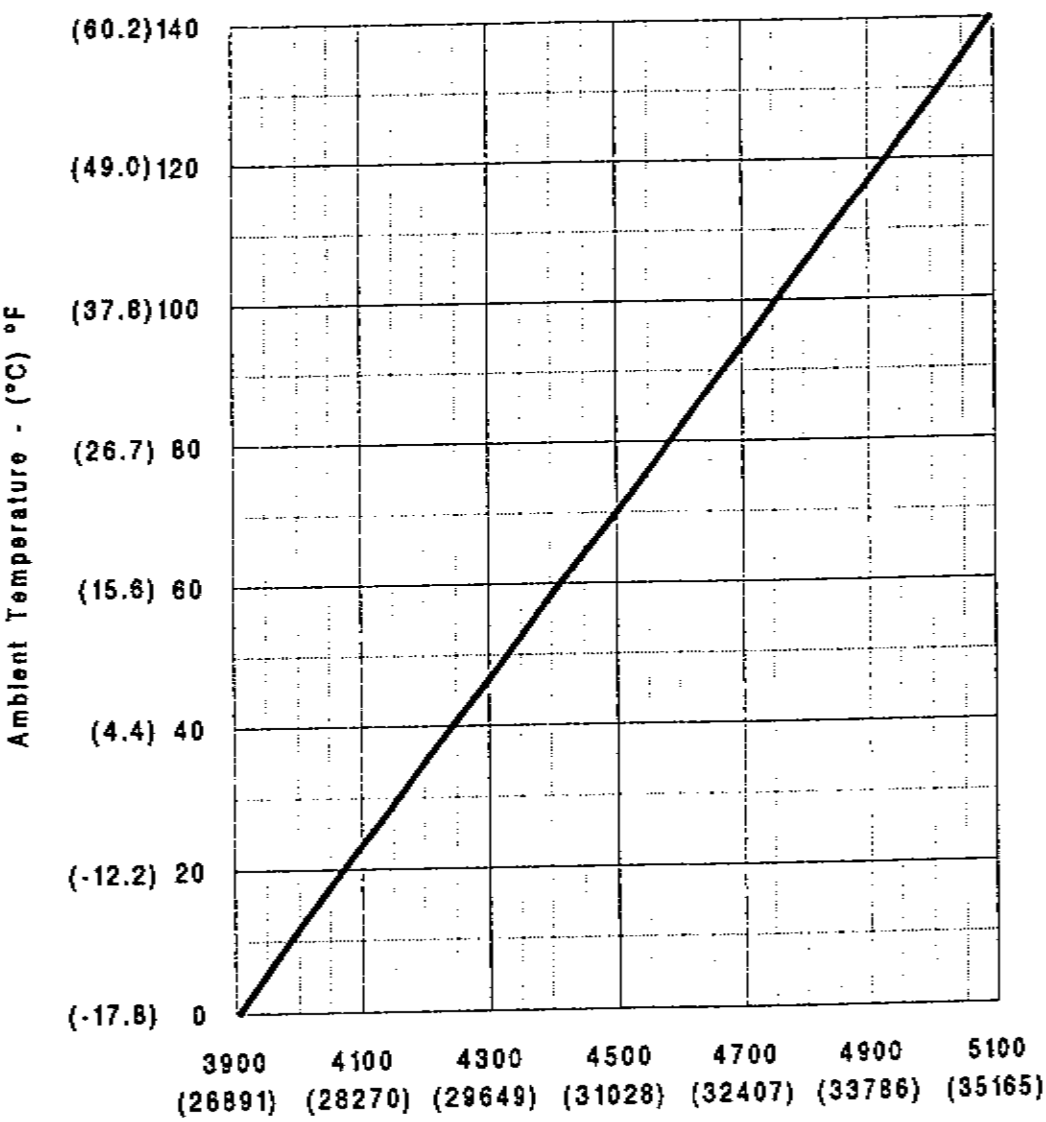


Figure 5-8-1. Nitrogen Cylinder Pressure

Section IV. Emergency Procedures

5-8-12. General

Refer to Chapter 3 of the basic Rotorcraft Flight Manual for general emergency procedures, including autorotation entry techniques, limitations, and recommendations. Touchdown speed should be reduced as much as practicable, however any "normal" autorotation speed should result in a safe landing. If possible, landings should be made in an area free of underwater obstacles such as submerged branches which may damage the floats. Landings and autorotational landings may be made on land with the floats inflated, however the float containers (covers) may be damaged in the process.

5-8-13. Engine Failure

1. Enter autorotation

2. Check airspeed is below 85 knots.

3. If landing is to be made in water, lift guard and pull float control handle to inflate floats. Be prepared for changes in the aircraft pitch attitude during the initial stages of the float deployment.

CAUTION

Do not inflate the floats more than 4000 feet above the intended landing area.

CAUTION

Full inflation of the floats requires approximately 15 seconds - maintain sufficient altitude, if possible, for full inflation of the floats in the event of an engine failure.

4. Complete normal autorotational landing.

5-8-14. Emergency Landing on Water with Power

1. Inspect the landing area for obstacles, both above and below the water.

2. Slow the aircraft to below 85 knots. The slower the airspeed is prior to float deployment, the less pitching will be experienced during inflation.

3. Lift guard and pull the float control handle to inflate floats.

CAUTION

Do not inflate the floats more than 4000 feet above the intended landing area.

CAUTION

Full inflation of the floats requires approximately 15 seconds - maintain sufficient altitude, if possible, for full inflation of the floats in the event of an engine failure.

4. Make a normal power-on landing.

CAUTION

With the aircraft in the water and the engine running, the engine exhaust will propel the aircraft forward. Moving the cyclic aft to stop the forward motion will cause the tail rotor to strike the water. The pilot should make allowance for this forward motion during the landing approach.

5. Make sure rotor has stopped before exiting aircraft.

5-8-15. Unusual Vibrations

Aircraft equipped with the increased rotor RPM kit (reference supplement #6) and floats may encounter unusual vibrations when operating at hover or low airspeeds with light cabin loads (solo pilot) and more than 500 pounds of fuel if the aircraft is not operated in accordance with Section 3 of this supplement or the pylon support struts are not properly rigged. These vibrations normally do not occur if any of the following three conditions exist:

1. Heavy cabin loads, such as more than one pilot and/or passenger on board.

2. Less than 500 pounds of fuel.

3. Low rotor RPM (357 RPM). With the increased rotor RPM kit, this is 99% N_2. With the standard aircraft, this is 101% N_2.

These vibrations normally do not occur at airspeeds above translation. All flight below translational lift airspeeds with light cabin loads and more than 500 pounds of fuel should be conducted at minimum RPM. If unusual vibrations are encountered in slow speed flight or hover, reduce the rotor speed as required. It should not be necessary to reduce the speed below the minimum power on rotor RPM. If the vibration persists, there are several techniques which can be used to stop them. The most appropriate will depend upon the severity of the vibrations and specific conditions of the flight.

1. Reduce RPM to the minimum power on speed.

2. Head the aircraft into the wind. The vibration is usually more pronounced with a tail wind.

3. Land the aircraft if a suitable landing site is available. Putting one skid on the ground will normally stop the vibration. In extreme conditions, a hovering autorotation can be used.

4. Accelerate into forward flight. The vibration normally ceases as the aircraft passes through approximately 25 KIAS. This technique should be used with caution as the vibration may increase between hover and forward flight; however it may be especially useful if the vibration appears part way into the take off profile.

If the aircraft seems unusually susceptible to vibrations, service the dampers and inspect the controls and main rotor for looseness.

Section V. PERFORMANCE

5-8-16. General

Except for cruise flight, the floats, when stowed, do not appreciably affect the performance of the aircraft.

5-8-17. Cruise

The floats reduce the cruise performance by an amount approximately equivalent to an additional 200 pounds of gross weight. To determine cruise performance, first determine the aircraft weight, cruise altitude, etc. Then refer to the appropriate cruise performance chart in the basic Rotorcraft Flight Manual (or Supplement 6, Section 5-6, as appropriate). Use the performance curve which is 200 pounds higher than the actual aircraft weight. That is, if the aircraft weight is 2550 pounds, use the 2750 pound curve. For aircraft weights above 2650 pounds, extrapolate the data shown in the figures. This 200-pound adjustment applies to cruise performance only. Hover performance, climb/descent performance, V_{NE}, etc. are not affected by the addition of the floats.

Section VI. Weight and Balance

5-8-10. General

The floats and the cylinder can be easily removed from the aircraft. The lines, hoses, control handle, and brackets are permanent. A new weight and balance should be calculated per the instructions in Section 6 of the Basic Flight Manual using the information below:

ITEM	Weight (lb)	Arm (in)	Moment (in-lb)
Permanent components	14.51	142.51	2067.8
Floats: Set of six with skid tube extensions	68.29	143.34	9788.6
Nitrogen Cylinder, Full	23.28	109.15	2541.1
Total Installed Weight	106.08	135.72	14397.5
Weight without Cylinder	82.80	143.19	11856.4

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 6

WEIGHT/ BALANCE AND LOADING

SECTION I. GENERAL

6-1. General Chapter 6 contains sufficient instructions and data so that the pilot can compute any combination of weight and balance. This helicopter must be flown within the weight and center of gravity limits stated in Chapter 1, Operating Limitations.

6-2. Helicopter Station Diagram Figure 6-1 shows the helicopter fuselage stations. The station reference datum is 143.4 inches forward of the center of the main rotor head, on the extended centerline of the fuselage. The primary purpose of the figure is to aid personnel in the computation of helicopter weight and balance and loading.

NOTE

The right hand seat track of the forward passenger seat is also stamped to identify c.g. location for occupants in that seat and should be used in calculating c.g. when occupied.

6-3. Loading Charts

a. Purpose. The loading data contained in this chapter is intended to provide information necessary to properly load the 480 and calculate its weight and center of gravity for the intended flight.

b. Use. From the figures contained in this chapter, weight and moment are obtained for all variable load items and are added to the current basic weight and moment found on Form F-511-5, Figure 6-4, to obtain the gross weight and moment. Removal or installation of approved optional equipment will change the helicopter weight and C.G. These changes shall be recorded on Form F-511-5, Figure 6-4, and a running basic total weight, arm, and moment will be maintained. The pilot will use this running basic total when performing calculations to insure the helicopter is loaded properly.

6-4. Center of Gravity Limits The gross weight and C.G. are checked using Figure 6-5 to determine if the aircraft is loaded within the proper limits for flight.

NOTE

A check should be made to determine whether or not the CG will remain within limits for the entire flight as fuel is consumed.

6-5. Fuel Loading The purpose of the fuel loading chart, Figure 6-6, is to provide moment/100 data for varying quantity of fuel.

6-6. Oil Data

a. Oil MIL-L-7808. Weight per gallon is 7.74 pounds. Tank capacity is 1.5 gallons for a total weight of 11.6 pounds at station 153.

b. Oil MIL-L-23699. Weight per gallon is 8.4 pounds. Tank capacity is 1.5 gallons for a total weight of 12.6 pounds at station 153.

6-7. Personnel, Cargo, and Baggage

a. The personnel and Cargo loading chart, Figure 6-7, provides moment/100 for varying weights at the designated fuselage stations. Each line has a corresponding fuselage station associated with it. The line labelled "Right Front Passenger" is the line corresponding to the most forward position of the seat when the seat is in the center set of tracks. The lines labelled "Trackable Seats" represent the forward most and aft most positions the crew seats can be locked into for both the pilot seat and the right front seat when it is located in the right most set of tracks, ie. for the dual pilot configuration. The line associated with FS 101 represents the aft most position the right front seat can achieve when it is locked full aft. The line labelled "Rear Passengers" is for personnel or cargo placed in the rear seats with the seats locked down in position. The line labelled "Baggage Box (avg)" is an average for the baggage box.

NOTE

It is the responsibility of the pilot in command to calculate the weight and balance for the aircraft for each flight including legs within that flight where the loading of personnel or cargo changes.

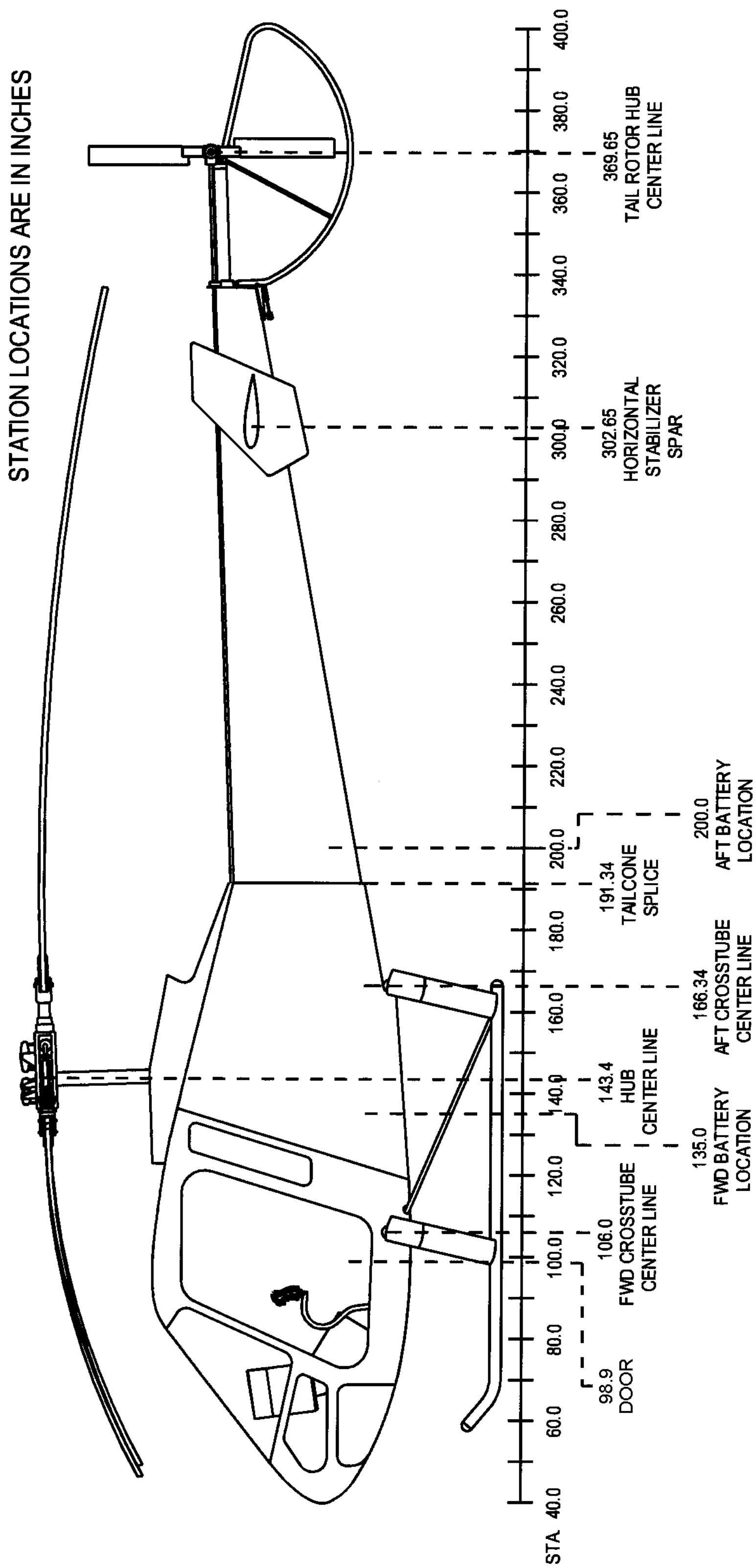


Figure 6-1. Helicopter Station Diagram

WEIGHT SHEET		
MODEL ____________	SERIAL NO. ____________	REG. NO. ____________

WEIGHT POINT	SCALE-LBS.	TARE	NET. WT.	ARM	MOMENT IN. LBS.
LEFT GEAR			(W_L)	143.4	
RIGHT GEAR			(W_R)	143.4	
TAIL			(W_T)	369.7	
TOTAL	XXX	X		X	

$$LCG = \frac{W_T\,(369.7) + (W_L + W_R)(143.6)}{W_T + W_L + W_R} = \text{----------------------}$$

$$= \text{-------------------} \text{ IN.}$$

Date ____________________ WEIGHED BY ____________________________

OR

COMPUTED BY____________________________

F-511-1

Figure 6-2. Form F-511-1

HELICOPTER WEIGHT AND C.G. CALCULATION

MODEL ____________ SERIAL NO. ____________ REG. NO. ____________

		WEIGHT LBS.	ARM IN.	MOMENT IN-LB.
WEIGHT (AS WEIGHED)				
PLUS: MISSING STD. EQUIPMENT			X	
LESS: OPT. & SURPLUS WT. (NEXT PAGE)			X	
LESS: ENGINE OIL				
PLUS: UNUSABLE FUEL (.3 or 1.7 gal per TCDS) (2.0 lbs or 11.4 lbs)		2.0	143.4	286.8
WEIGHT EMPTY STD. HELICOPTER	COMPUTED			
	ACTUAL			
PLUS: ENGINE OIL		12.6	X	1927.8
PLUS: OPTIONAL EQUIPMENT (NEXT PAGE)			X	

ITEMIZED MISSING STD EQUIP:

WT. LBS. ARM IN MOMENT IN-LB

NOTES: A/C weighed/calculated C.G. using the following data:
Oil: MIL-L-7808 is 7.74/Gal, MIL-L-23699 is 8.4/Gal.
Fuel Wt.: 6.7 lbs/gal

TOTAL BASIC WEIGHT & C.G.			

Figure 6-3. Form F-511-2 (Sheet 1 of 3)

ENSTROM TH-28, 480 OPTIONAL EQUIPMENT LIST

SERIAL NO. ________________

REGISTRATION NO. ________________ DATE ____________

NO.	ITEM	WT.	ARM
	INSTRUMENTS - REQUIRED (STD. EQUIP.)		
	Airspeed Indicator	.7	70.7
	Altimeter	1.10	69.9
	Clock	.5	72.0
	Compass	.75	68.5
	O.A.T.	.13	86.5
	Dual Tachometer	1.6	69.1
	Torque Indicator	1.0	69.9
	N1 Indicator	1.8	70.0
	T.O.T. Indicator	1.0	70.9
	Fuel Qty. Indicator	1.0	70.1
	Transmission Oil Temp.	1.0	69.4
	Engine Oil Temp./Press.	1.0	69.9
	AMP/Volt	1.0	70.3

NO.	OPTIONAL EQUIPMENT	WT.	ARM	MOMENT IN/LB

F-511-3

Figure 6-3. Form F-511-3 (Sheet 2 of 3)

ENSTROM TH-28, 480 OPTIONAL EQUIPMENT LIST CONTINUED

SERIAL NO. ____________
REGISTRATION NO. ______________ DATE ___________

NO.	ITEM	WT.	ARM	MOMENT

F-511-4

Figure 6-3. Form F-511-4 (Sheet 3 of 3)

6/7/93

BASIC WEIGHT AND BALANCE RECORD

MODEL NO. ________ SERIAL NO. ________ REG. NO. ________

ACTUAL DELIVERED WEIGHT AND BALANCE DATA												WEIGHT	ARM	MOMENT
ITEM NO.	DATE	ITEM		DESCRIPTION	WEIGHT ADDED+			WEIGHT REMOVED-			RUNNING BASIC TOTAL		
		IN	OUT	OR MODIFICATION	WEIGHT	ARM	MOMENT	WEIGHT	ARM	MOMENT	WEIGHT	ARM	MOMENT

F-511-5

Figure 6-4. Form F-511-5

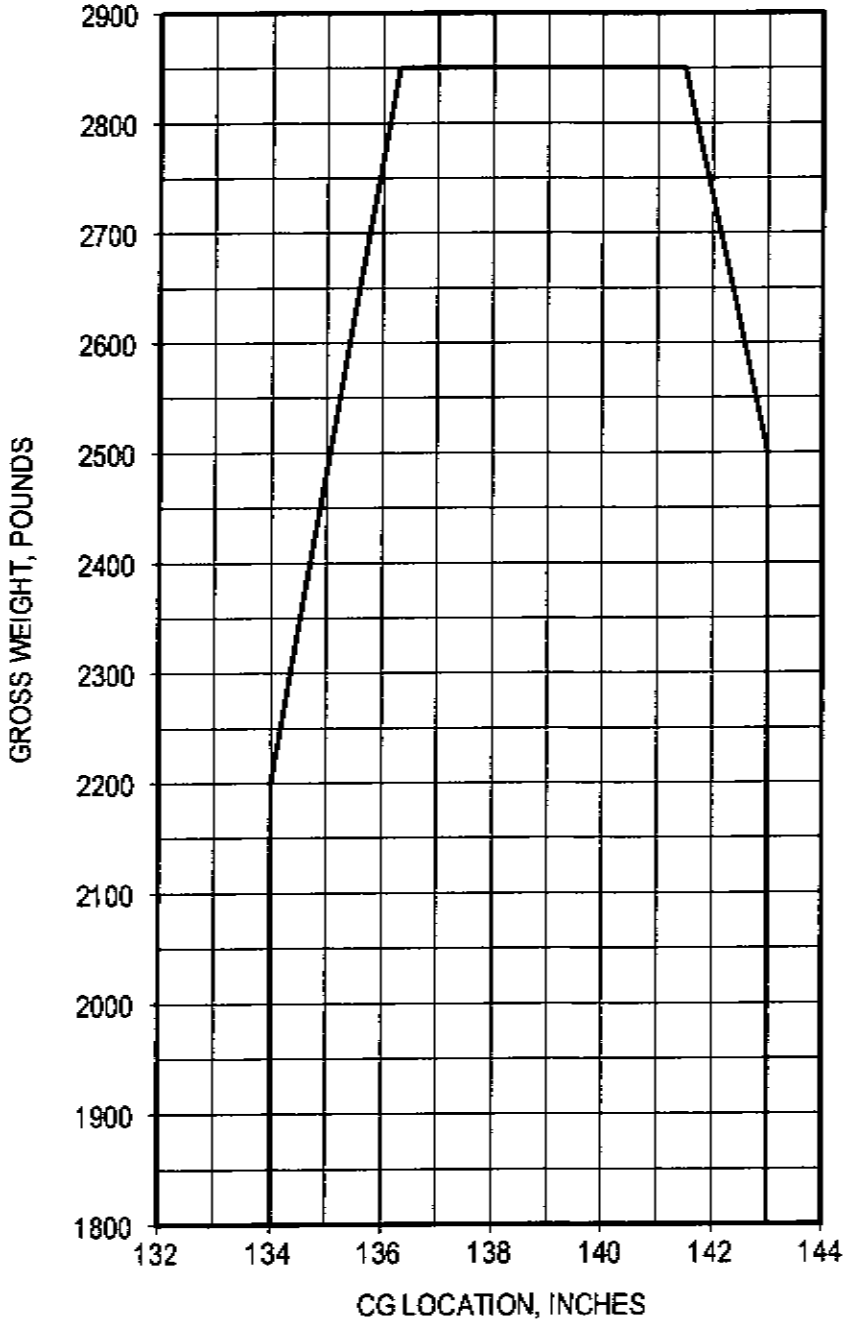


Figure 6-5. Weight and C.G. Limits

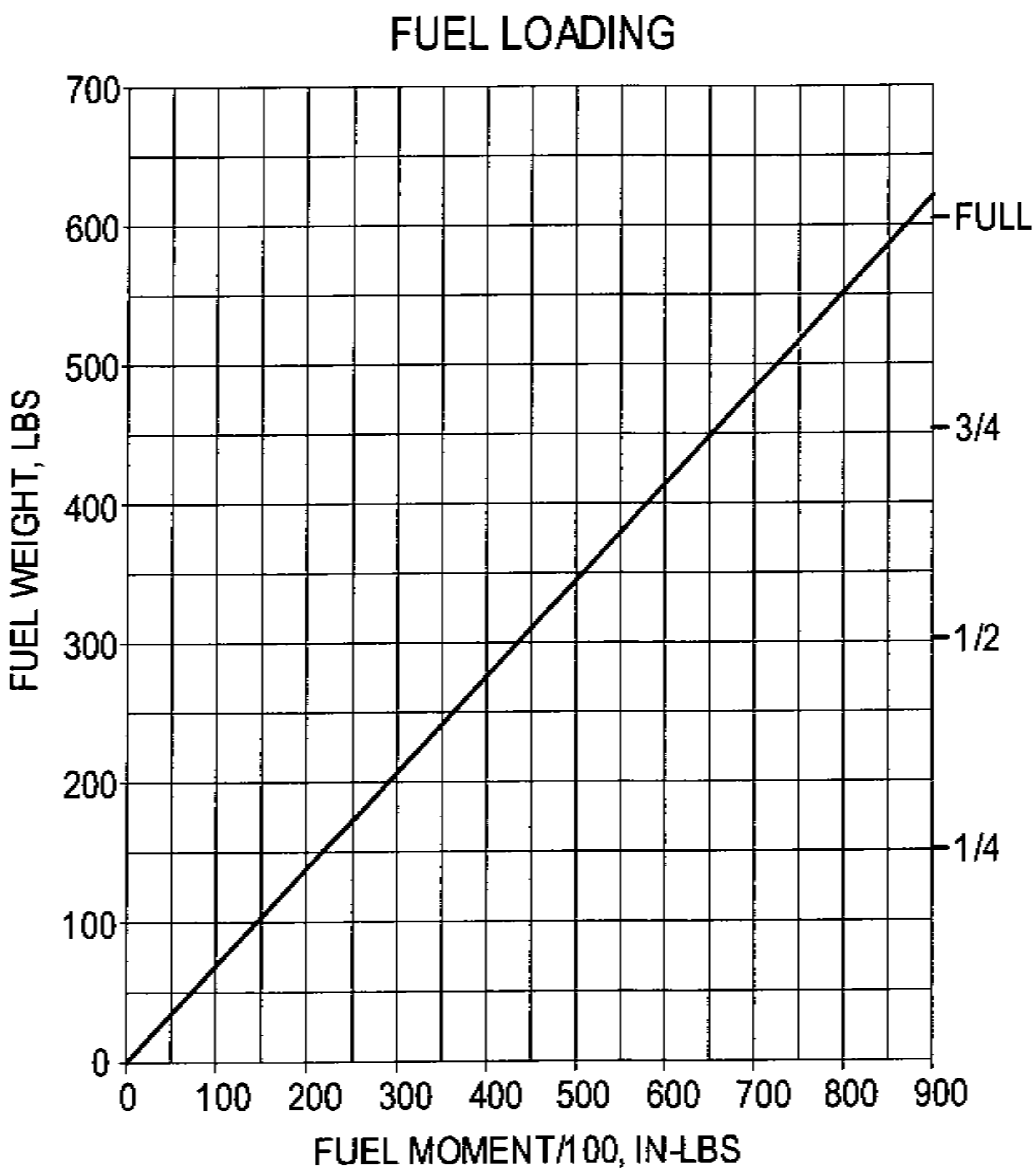


Figure 6-6. Fuel Loading Chart

CAUTION

It is possible to exceed the aft C.G. limits of the aircraft when operating solo. Relocation of the battery to the forward battery location may be required with solo pilot. It is also possible to exceed the forward C.G. limits of the aircraft when operating with a pilot plus three or more passengers on board. Strategic placement of heavier personnel and baggage may be required to remain within the C.G. envelope of the aircraft.

b. When the helicopter is operated at critical loading conditions, the exact weight of each individual occupant plus equipment shall be used. To assist the pilot in deciding on loading arrangements to remain within the allowable weight and C.G. range prior to calculating the weight and balance for the aircraft, the following general guidelines are provided:

1. Do not load any cargo, baggage, or weight in the baggage compartment when flying single pilot. Note that the V_{NE} changes with C.G.

2. When carrying three or more passengers, calculate the C.G. using the specific station for the front passenger seat used in flight. Some restriction in passenger weight for the front seat may apply. Relocation of the battery to the baggage box location may also be necessary to accommodate the higher cabin loads.

3. When carrying two or more passengers the tradeoff for weight in the right front seat versus weight in the baggage compartment for CG control is one pound of baggage for one pound for passengers weighing more than 150 lb, ie. in general if a 200 lb passenger is riding in the right front seat then approximately 50 lb will have to be carried in the baggage compartment to offset the additional front seat weight.

NOTE

Whenever possible restrict the right front passenger seat to 150 lbs when it is forward of FS 98 and load heavier passengers in the rear seats.

6-8. Battery

The aircraft battery is normally located in the forward, right side area of the engine compartment (station 135, butt line 25.5). The battery can be moved into the baggage box (station 200, butt line -13.5) to help control the center of gravity, especially with heavy loads in the cabin. Moving the battery will not change the weight of the aircraft but will significantly alter the center of gravity. As such, it is important to know both the present location of the battery and the location of the battery which was used to derive the empty weight (Forms F-511-2 and F-511-5, Figures 6-3 and 6-4).

Moving the battery from the forward location to the aft location has the effect of increasing the longitudinal moment and decreasing the lateral moment. Moving the battery from the aft location to the forward location will have the opposite effect. To determine the change in longitudinal and lateral moments, multiply the weight of the battery by the values in the following table:

Battery Position	Multiplier	
	Longitudinal	Lateral
Moving forward to aft	+65	-39
Moving aft to forward	-65	+39

<u>Example</u>:
Moving a 42.5 lb battery from the forward location to the aft location will change the moments as follows:

Longitudinal: 42.5 X 65 = 2762 in-lbs
Lateral: 42.5 X -39= -1657 in-lbs

The battery type and manufacturer may vary from aircraft to aircraft. For accuracy, weigh the battery prior to relocating when computing the new weight and balance.

6-9. Operation Without Doors

1. The standard door weight is 14 lbs at station 98. The operator is encouraged to weigh the door for accuracy as the actual door weight will vary depending on options and cabin interior. Record the door weight on Form F-511-5 (Figure 6-4) if operating without a door(s), as applicable.

6-9.1 Lateral Center of Gravity

For virtually any typical loading, the lateral center of gravity will remain well within the limits for the aircraft (see Chapter 1). However, the pilot should be aware of asymmetrical loadings and check the lateral moment prior to flight, especially if an unusal loading condition is encountered. The appropriate lateral arms (butt lines) are listed below. For items which are not listed, the arm can be determined by measuring from the aircraft centerline to the center of gravity of the item, using negative distances for items left of center and positive distances for items to the right of center. Moment is determined by multiplying the weight of the item by its lateral arm.

ITEM	LATERAL ARM (BUTT LINE) (IN)
Pilot Seat:	-20.25
Right Front Seat:	
Outboard Rails	21.25
Inboard Rails	11.5
Center (Rear) Seat In 3-Seat Configuration	1.0
Rear Seat with 2 Passengers:	
Outboard Passenger	24
Inboard Passenger	1.0
Rear Seat with 3 Passengers:	
Outboard Passenger	26
Middle Passenger	14
Inboard Passenger	-2
Baggage Behind Pilot Seat (On Cabin Shelf)	-24
Fuel	0

6-10. Sample Loadings. Sample loading calculations are provided below:

SINGLE PILOT

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
PILOT	180	99	17,820.0	-20.25	-3645
CP OR PAX IN CP POSITION		99		21.25	
CENTER PAX		113.1		1.0	
RIGHT REAR PAX		113.1		24	
BAGGAGE (behind pilot seat)		119		-24	
BAGGAGE (aft compartment)		192		0	
ZERO FUEL WEIGHT AND CG	1,950.00	142.41	277,708.7		-3645
FUEL (full)	605	144.63	87500	0	0
TAKEOFF WEIGHT AND CG	2,555.00	142.94	365,208.7		-3645

DUAL PILOT

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
DUAL CONTROLS	4.2	119	499.8	15	63
PILOT	170	99	16,830.0	-20.25	-3442
CP OR PAX IN CP POSITION	170	99	16,830.0	21.25	3612
CENTER PAX		113.1	0.0	1.0	
RIGHT REAR PAX		113.1	0.0	24	
BAGGAGE (behind pilot seat)		119		-24	
BAGGAGE (aft compartment)		192		0	
ZERO FUEL WEIGHT AND CG	2,114	139.08	294,048.5		233
FUEL	605	144.63	87500	0	0
TAKEOFF WEIGHT AND CG	2,719	140.33	381,548.5		233

DUAL PILOT WITH CABIN BAGGAGE

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
DUAL CONTROLS	4.2	119	499.8	15	63
PILOT	170	99	16,830.0	-20.25	-3442
CP OR PAX IN CP POSITION	170	99	16,830.0	21.25	3612
CENTER PAX		113.1	0.0	1.0	
RIGHT REAR PAX		113.1	0.0	24.0	
BAGGAGE (behind pilot seat)	50	119	5,950.0	-24.0	-1200
BAGGAGE (aft compartment)		192		0	
ZERO FUEL WEIGHT AND CG	2,164.00	138.63	299,998.5		-969
FUEL	605	144.63	87500	0	0
TAKEOFF WEIGHT AND CG	2,769.00	139.94	387,498.5		-969

DUAL PILOT PLUS BAGGAGE

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
DUAL CONTROLS	4.2	119	499.8	15	63
PILOT	170	99	16,830.0	-20.25	-3442
CP OR PAX IN CP POSITION	170	99	16,830.0	21.25	3612
CENTER PAX		113.1		1.0	
RIGHT REAR PAX		113.1		24.0	
BAGGAGE (behind pilot seat)	50	119	5,950.0	-24.0	-1200
BAGGAGE (aft compartment)	60	192	11,520.0	0	0
ZERO FUEL WEIGHT AND CG	2,224	140.07	311,518.5		-969
FUEL	605	144.63	87500	0	0
TAKEOFF WEIGHT AND CG	2,829	141.06	399,018.5		-969

DUAL PILOT PLUS PASSENGER WITH 60 LBS BAGGAGE

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
DUAL CONTROLS	4.2	119	499.8	15	63
PILOT	170	99	16,830.0	-20.25	-3442
CP OR PAX IN CP POSITION	170	99	16,830.0	21.25	3612
CENTER PAX	170	113.1	19,227.0	1.0	170
RIGHT REAR PAX		113.1		24.0	
BAGGAGE (behind pilot seat)		119		-24.0	
BAGGAGE (aft compartment)	60	192	11,520.0	0	0
ZERO FUEL WEIGHT AND CG	2,344	138.56	324,795.5		403
FUEL	506	144.12	72925	0	0
TAKEOFF WEIGHT AND CG	2,850	139.55	397,720.5		403

DUAL PILOT PLUS PASSENGER PLUS 90 LBS BAGGAGE

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
DUAL CONTROLS	4.2	119	499.8	15	63
PILOT	170	99	16,830.0	-20.25	-3442
CP OR PAX IN CP POSITION	170	99	16,830.0	21.25	3612
CENTER PAX	170	113.1	19,227.0	1.0	170
RIGHT REAR PAX		113.1		24.0	
BAGGAGE (behind pilot seat)		119		-24.0	
BAGGAGE (aft compartment)	90	192	17,280.0	0	0
ZERO FUEL WEIGHT AND CG	2,374	139.24	330,555.5		403
FUEL	476	145.83	69415	0	0
TAKEOFF WEIGHT AND CG	2,850	140.34	399,970.5		403

PILOT PLUS 3 PASSENGERS WITH 60 LBS BAGGAGE

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
PILOT	170	99	16,830.0	-20.25	-3442
FORWARD PAX	150	89	13,350.0	11.5	1725
CENTER PAX	170	113.1	19,227.0	1.0	170
RIGHT REAR PAX	170	113.1	19,227.0	24.0	4080
BAGGAGE (behind pilot seat)		119		-24.0	
BAGGAGE (aft compartment)	60	192	11,520.0	0	0
ZERO FUEL WEIGHT AND CG	2,490	136.56	340,042.7		2533
FUEL	360	145.83	52,500	0	0
TAKEOFF WEIGHT AND CG	2,850	137.73	392,542.7		2533

PILOT PLUS 3 PASSENGERS WITHOUT BAGGAGE

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
PILOT	170	99	16,830.0	-20.25	-3442
FORWARD PAX	150	89	13,350.0	11.5	1725
CENTER PAX	170	113.1	19,227.0	1.0	170
RIGHT REAR PAX	170	113.1	19,227.0	24.0	4080
BAGGAGE (behind pilot seat)		119		-24.0	
BAGGAGE (aft compartment)		192		0	
ZERO FUEL WEIGHT AND CG	2,430	135.19	328,522.7		2533
FUEL	420	147.62	62,000	0	0
TAKEOFF WEIGHT AND CG	2,850	137.03	390,522.7		2533

PILOT PLUS 3 PASSENGERS PLUS 110 LBS BAGGAGE

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
PILOT	170	99	16,830.0	-20.25	-3442
FORWARD PAX	150	89	13,350.0	11.5	1725
CENTER PAX	170	113.1	19,227.0	1.0	170
RIGHT REAR PAX	170	113.1	19,227.0	24.0	4080
BAGGAGE (behind pilot seat)		119		-24.0	
BAGGAGE (aft compartment)	110	192	21,120.0	0	0
ZERO FUEL WEIGHT AND CG	2,540	137.65	349,642.7		2533
FUEL	310	146.77	45,500	0	0
TAKEOFF WEIGHT AND CG	2,850	138.65	395,142.7		2533

PILOT PLUS 3 PASSENGERS (HEAVY PASSENGER UP FRONT)
BATTERY RELOCATED AFT

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259888.7		
PILOT	170	99	16,830.0	-20.25	-3442
FORWARD PAX	200	89	17,800.0	11.5	2300
CENTER PAX	170	113.1	19,227.0	1.0	170
RIGHT REAR PAX	170	113.1	19,227.0	24.0	4080
BATTERY RELOCATED AFT	no change	135 to 200	2,697		-1618
BAGGAGE (behind pilot seat)		119		-24.0	
BAGGAGE (aft compartment)		192		0	
ZERO FUEL WEIGHT AND CG	2,480	135.35	335,669.7		1490
FUEL	370	146.77	54,305.4	0	0
TAKEOFF WEIGHT AND CG	2,850	136.83	389,974.6		1490

PILOT PLUS 4 PASSENGERS
BATTERY RELOCATED AFT

COMPONENT	WEIGHT	ARM	MOMENT	LATERAL ARM	LATERAL MOMENT
BASIC EMPTY WEIGHT/CG	1770	146.83	259,888.7		
PILOT	170	99	16,830.0	-20.25	-3442
FORWARD PAX	150	89	13,350.0	11.5	1725
INBOARD REAR PAX	150	113.1	16,965.0	-2	-300
RIGHT REAR PAX	150	113.1	16,965.0	14	2100
MIDDLE REAR PAX	150	113.1	16,965.0	26.0	3900
BATTERY RELOCATED AFT	no change	135 to 200	2,697		-1618
BAGGAGE (behind pilot seat)		119		-24.0	
BAGGAGE (aft compartment)		192		0	
ZERO FUEL WEIGHT AND CG	2,540	135.30	343,660.7		3983
FUEL	310	146.77	45,498.7	0	0
TAKEOFF WEIGHT AND CG	2,850	136.55	389,159.4		3983

SECTION II. WEIGHT AND BALANCE FORMS

6-11. Forms 511-1, 511-2 and 511-5

These three forms are usually prepared by Enstrom at the time of delivery of the helicopter. Form 511-1 is the initial weight record of the aircraft. It lists the actual scale readings or indicates that the weight and balance is based on a standard computation for this aircraft. This form is the basis for forms 511-2 and 511-5. Form 511-2 is the basic delivered weight and balance form for the aircraft as delivered. Form 511-5 is a continuous history of the basic weight and moment resulting from structural and equipment changes. The last entry is the current weight and balance status of the basic helicopter. Figure 6-3 shows a sample Form 511-2 and Figure 6-4 shows a sample Form 511-5.

6-12. Form F-170

a. Form F-170, Figure 6-8, is a summary of the actual distribution of the load in the helicopter. It records the balance status of the helicopter step by step. It serves as a worksheet on which to record weight and balance calculations, and any corrections that must be made to ensure that the helicopter will be within weight and CG limits. This form may be reproduced as desired for weight and balance calculations.

b. Form Preparation.

(1) First Line: This line is always reserved for the basic empty weight, arm, and moment of the aircraft taken directly from the last line of Form F-511-5.

(2) Second line: This line is for the pilot and co-pilot combined weight and moment.

(3) Third and forth lines: These lines are for the passengers, if any.

NOTE

In the 480, the seat C.G. locations for calculating weight and balance are as follows:

Pilot Seat	**F.S. 97, 98, 99, 100, 101**
Co-Pilot Seat (When installed in the right most seat track)	**F.S. 97, 98, 99, 100, 101**
R.H. Seat (Staggered Forward) (4 passenger)	**F.S. 89 thru 101 @ 1" intervals**
Aft Seats	**F.S. 113.1**

(4) Fifth and Subsequent Lines: These lines are for any baggage or other items of equipment carried aboard the aircraft, and their weight, arm, and moment.

(5) Zero Fuel Condition: This line is a sub-total of all of the weights listed in the weight column, and the moments in the moment column. The lateral moment is the total of the moments in the "Lateral Moment" column. The Zero Fuel Weight CG is then calculated by dividing the Zero Fuel Condition Moment total by the Zero Fuel Condition Weight total and recording that value in the arm column.

NOTE

DO NOT total the "ARM" Columns.

(6) Fuel: This line is for the takeoff fuel weight, arm, and moment.

(7) Takeoff Condition: This line is the final tally of the Zero Fuel Condition subtotals added together with the values on the Fuel line for both the weight and the moment columns. The aircraft takeoff CG is then calculated by dividing the moment total by the takeoff weight total and entering that value in the Takeoff Weight arm column.

NOTE

DO NOT total the "ARM" column.

c. The final step in the Weight and Balance form is to plot the Zero Fuel Weight and CG and the Takeoff Weight and CG on the graph at the far right on the form and connect the two points by a straight line. This will then be a graphical representation of the CG shift with fuel burn and from this data the pilot can easily determine where the aircraft will fall relative to the aircraft weight and CG limits for the intended flight. The lateral moment can be compared directly to the moment limit (±7500 in-lbs) listed in Chapter 1.

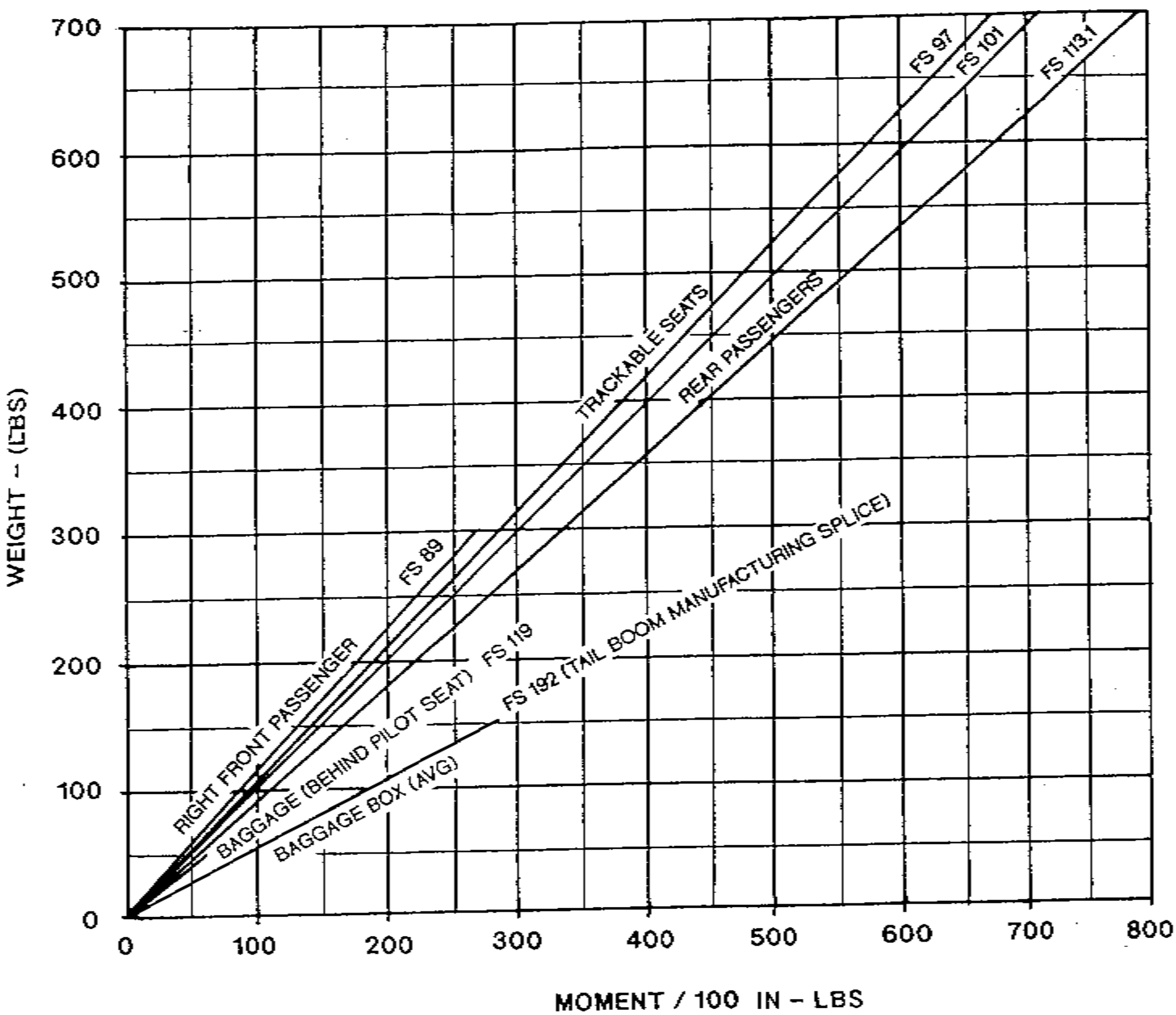


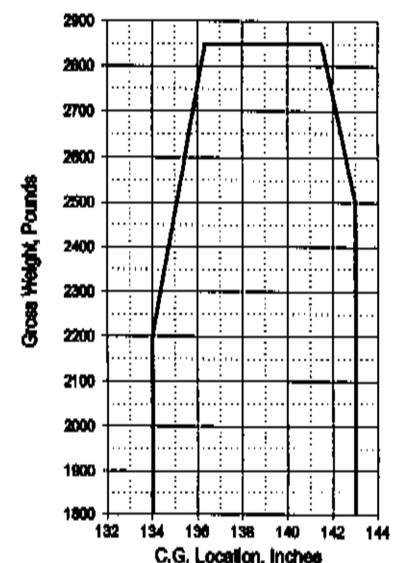
Figure 6-7. Personnel/Cargo/Baggage Loading Charts

FORM F-170 AIRCRAFT WEIGHT & BALANCE

Date__________ A/C__________

	Component	Weight	Longitudinal		Lateral	
			Arm	Moment	Arm	Moment
①	Basic Empty Weight					
②						
③						
④						
⑤	Zero Fuel Condition					
⑥	Fuel: GAL LBS					
⑦	Takeoff Condition					

Fwd Edge of Cockpit Floor	71.5
Right & Left Pilot	97 to 101 in 1 inch increments
Right Forward Passenger	89 to 101 in 1 inch increments
Rear Passengers	113.1
Fuel (Full)	See Chart
Baggage Box	FS 192 Avg



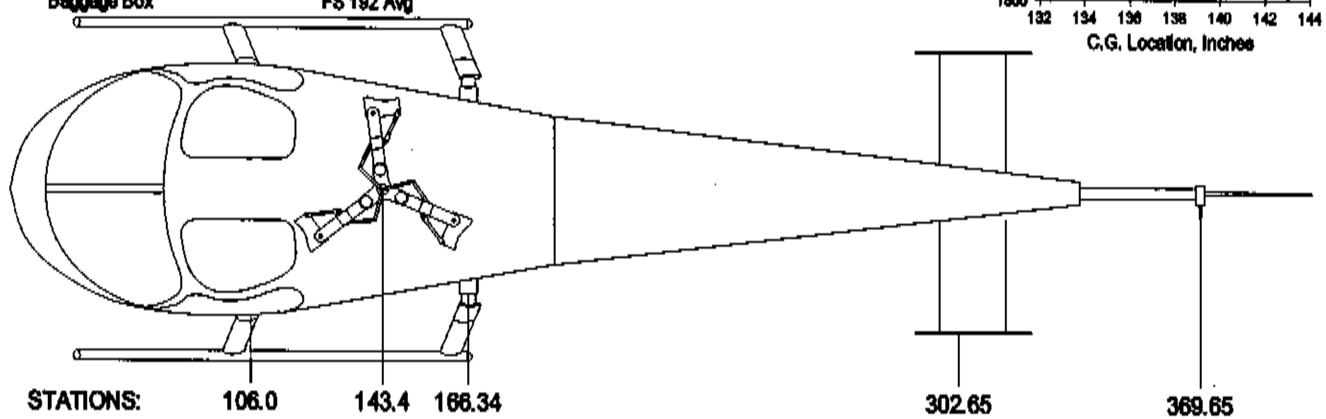


Figure 6-8. Form F-170

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 7

HELICOPTER AND SYSTEMS DESCRIPTION AND OPERATION

SECTION I. HELICOPTER

7-1. General Description The Enstrom model 480 helicopter is a 5 place, 3 bladed, single engine helicopter. The aircraft is designed for mission flexibility. It may be configured to transport (5) people, or easily converted to a (3) place primary trainer or a solo pilot light cargo transport. Particular attention has been given to make it easily convertible.

7-2. General Arrangement Figure 7-1 depicts the general arrangement. Indexed items include access openings and most of the items referred to in the exterior check paragraph in Section II of Chapter 2.

7-3. Principal Dimensions Figures 7-2.1 and 7-2.2 depict the principal dimensions of the aircraft.

7-4. Turning Radius The turning radius is about 21 feet when pivoted about the mast.

7-5. Fuselage The fuselage consists of the cabin, the center section and the tailcone. The cabin consists of a composite cabin shell with a honeycomb floor and backwall attached to a sheet aluminum subfloor structure which is also referred to as the keel.

The backwall and keel structures are attached to a welded steel tubular truss structure called the pylon. The main keel beams are the supporting structure for the cabin and forward landing gear cross tube. The pylon forms the supporting structure for the cabin, fuel cells, transmission, engine, aft landing gear cross tube, and the tailcone. The cabin shell is all composite, consisting of multiple layers of fiberglass with reinforcing where necessary to add structural stiffness.

7-6. Tailcone The tailcone section is bolted to the aft end of the pylon and extends to the aft end of the helicopter. It is a tapered, semi-monocoque structure comprised of aluminum skins, longerons, and stringers. The tailcone supports the tail rotor, horizontal and vertical stabilizers, and the tail rotor guard. It houses the tail rotor drive shaft, some electronic equipment, and the baggage box.

7-7. Landing Gear System

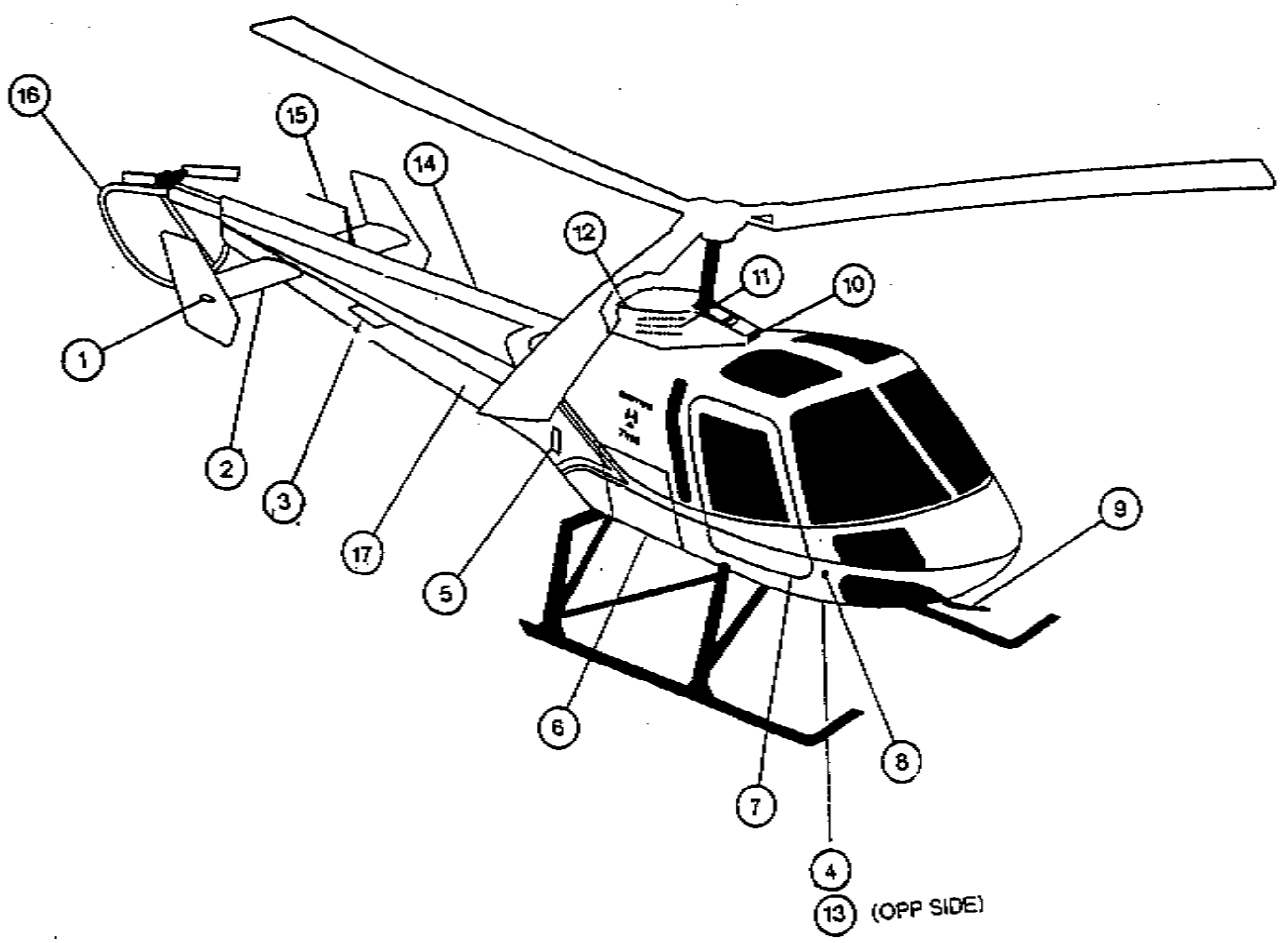
a. Skid Landing Gear. The main landing gear consists of two tubular aluminum skids attached to the airframe by means of the forward and aft cross tubes through four pivoting legs and four air-oil oleo struts. The struts cushion ground contact during landing. Drag struts give the gear stability and strength and prevent fore and aft movement during ground contact maneuvers. Replaceable hardened steel skid shoes are installed on each skid to resist skid wear on hard surfaces.

b. Tail Rotor Guard. A tubular tail rotor guard is installed on the aft end of the tailboom. It acts as a warning to the pilot upon an inadvertent tail-low landing and aids in protecting the tail rotor from damage.

c. Ground Handling Wheels. Each landing gear skid tube has provisions for easily installing dual landing gear ground handling wheel assemblies. Each skid has four lugs installed over which the wheel assemblies slide. Each assembly has a manually operated over-centering device to lift the skids clear of the ground. The ground handling wheels must be removed before flight.

7-8. Cabin. The cabin consists of one pilot seat on the left side of the cockpit, two or three abreast seating in the rear and one dual purpose passenger or co-pilot seat on the right front. The aircraft is equipped with two complete sets of flight controls, one optional. The instrument console and radio pedestal are mounted at the forward end of the cabin floor slightly to the left of center.

7-9. Cabin Doors The two cabin doors are composite reinforced structure with transparent plexiglass windows in the upper section. Ventilation is supplied by the optional sliding panels in the windows. Positive retention door latches are used. Doors can be equipped with optional jettisonable door releases.



1. Anticollision/navigation light
2. Horizontal/vertical stabilizer assembly
3. VOR/LOC Antenna - if installed
4. #2 Com antenna - if installed
5. Oil cooler Exhaust
6. Right engine compartment access
7. Right Cabin Door
8. Static port - pitot/static system reference
9. Pitot tube - standard location
10. Transmission cooling air intake
11. Engine air intake and upper plenum
12. Upper pulley fan exhaust
13. #1 Com Antenna - if installed
14. Tail rotor driveshaft
15. Loran antenna - if installed
16. Tail rotor guard
17. Static port - engine inlet air caution reference

Figure 7-1. General Arrangement Diagram

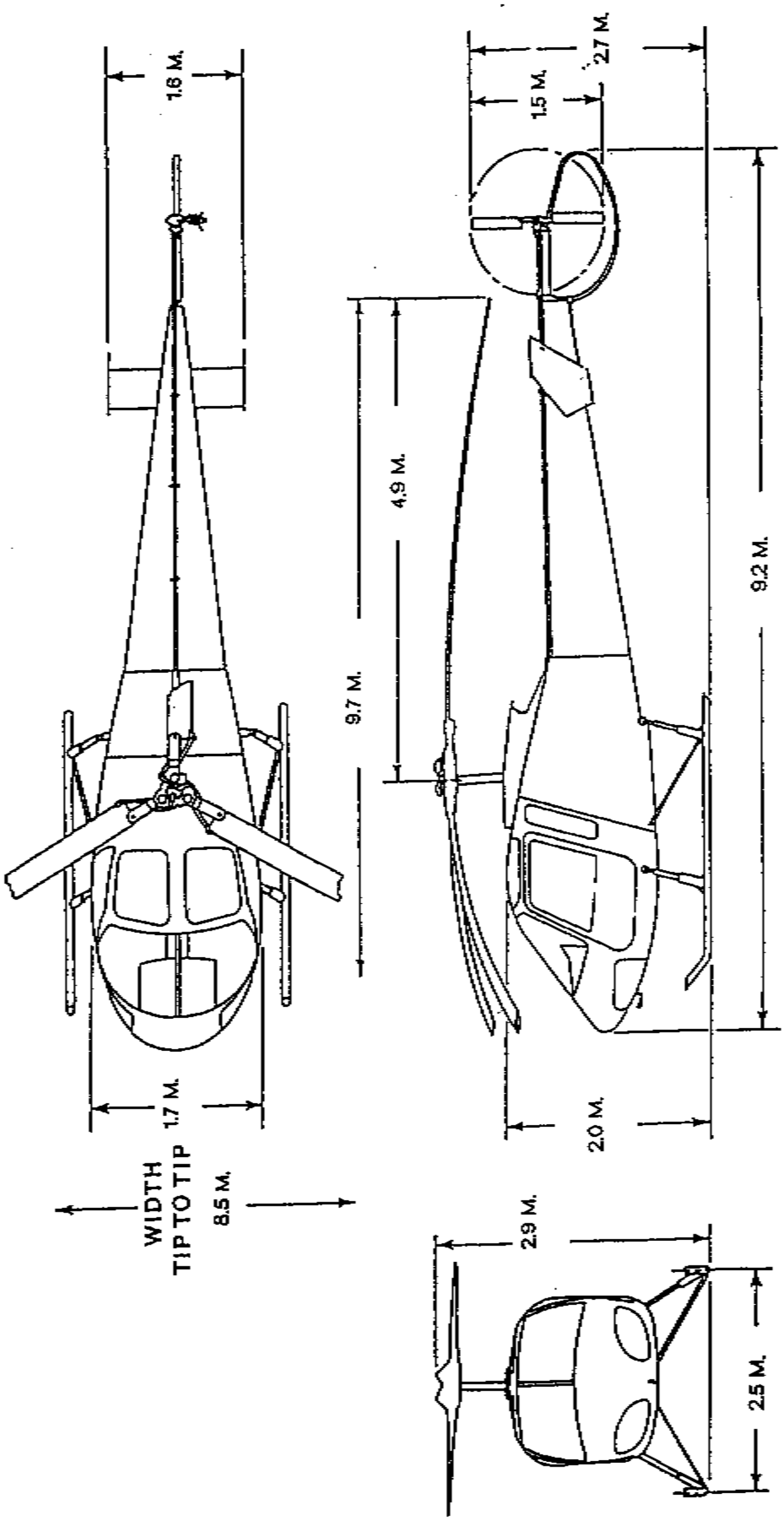


Figure 7-2.1 Principle Dimensions Diagram

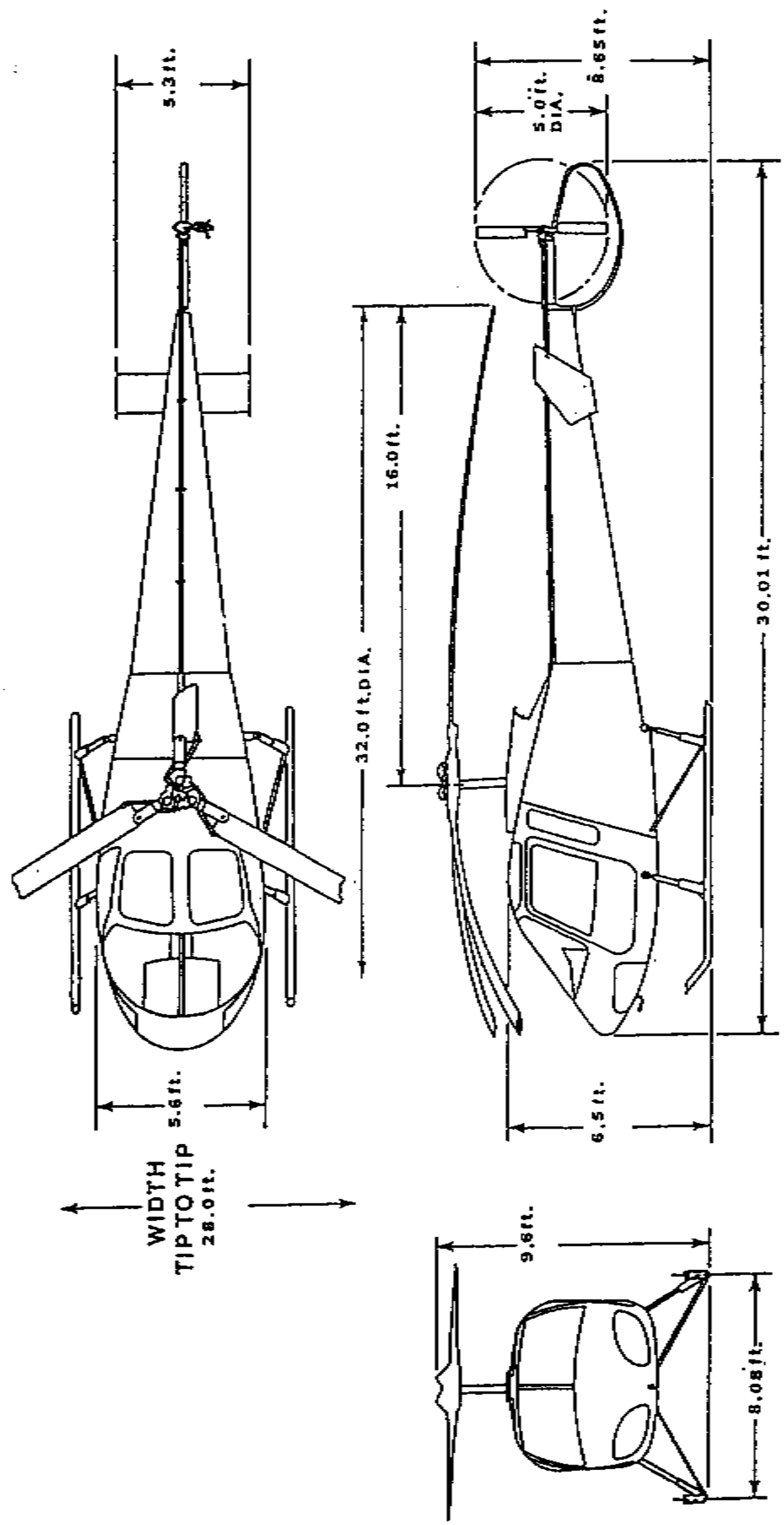


Figure 7-2.2 Principle Dimensions Diagram

7-10. Seats

a. Pilot and Copilot Seats. The pilot and copilot seats are tracked adjustable, conventional aircraft seats. The seat includes a lap belt with an inertial reel dual shoulder harness.

b. Rear Passenger Seats. The passenger seats are mounted to the backwall and consist of two honeycomb panels that fold down from the backwall. Some models are configured with twin back seats and others are configured with a cushion arrangement for three (3) back seat passengers with individual combination diagonal shoulder harness and lap belt restraints. The twin seat arrangement uses the same shoulder harness as the front seats.

c. Front Passenger Seat. The right front crew seat (co-pilot seat) also doubles as a passenger seat when the dual controls are removed. The seat may be left in the seat tracks for the co-pilot position or may be moved over one set of tracks to allow more room for the rear passengers. To move the seat, pull up on both the adjusting lever and the latch handle under the seat base and slide the seat approximately 1/2" forward or aft until the center posts rest on top of the seat tracks in between holes. At that point, the forward and aft legs will be positioned in the holes so the seat can be lifted straight up and free of the tracks. To re-install, reverse the process.

NOTE

The co-pilot seat shall not be moved over to the center (left set of tracks) unless the extended flooring has been installed in the right chin window and the right set of flight controls removed and stowed and the protective covers installed.

The center track of the three on the right side of the cabin is common to both seat installation positions. In the co-pilot position, the center track is the left seat track for the seat. In the staggered passenger position, the center seat track becomes the right seat track for the passenger seat.

d. Inertia Reel Shoulder Harness. An inertia reel and shoulder harness is incorporated in each seat. There is no independent control to manually lock the harness. With the shoulder straps properly adjusted, the reel strap will extend to allow the occupant to lean forward; however, the reel automatically locks when the helicopter encounters an impact force of 2 to 3 "G" deceleration. To release the lock, it is necessary to lean back slightly to release tension on the lock. The shoulder straps must be adjusted properly to prevent rebound overshoot in the event of impact.

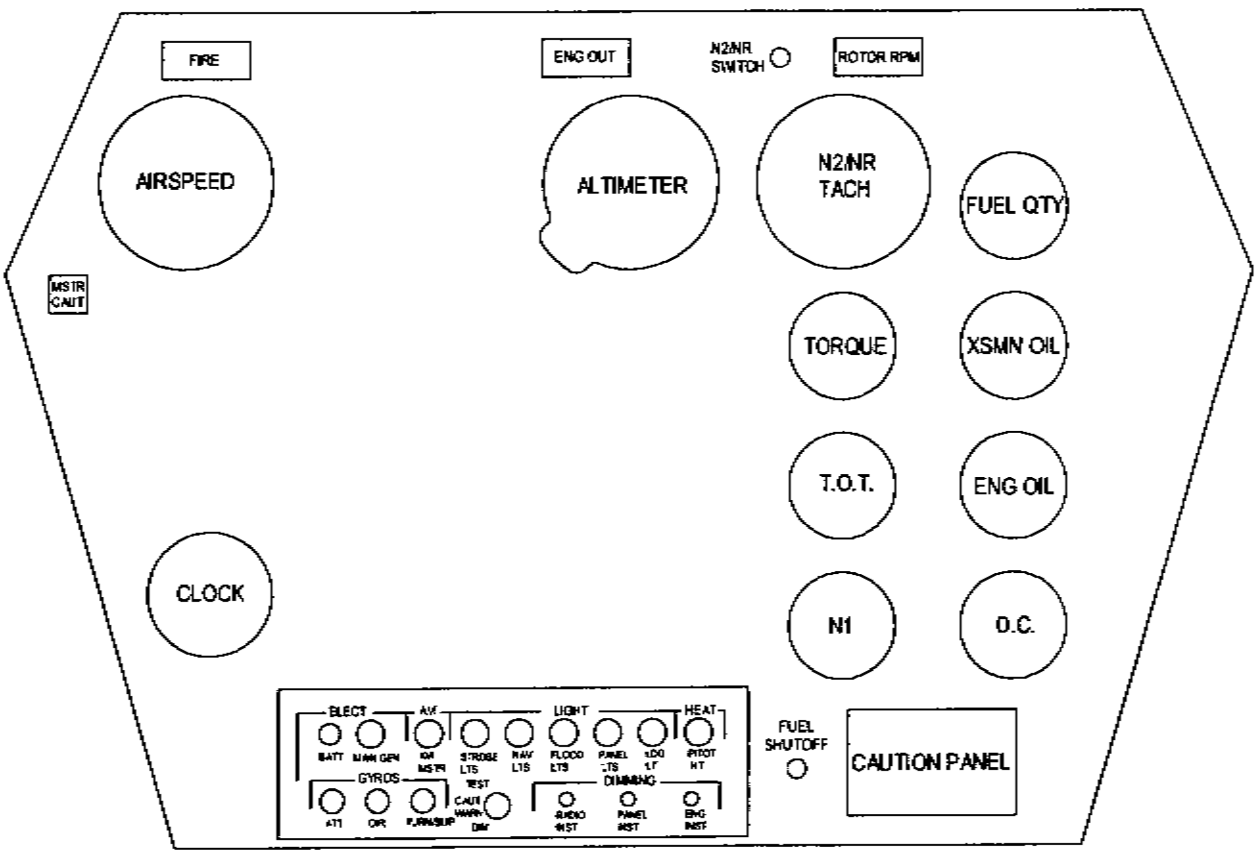
e. Dual Control Removal. The right set of flight controls is removable for the single pilot plus cargo or passenger case. To remove the tail rotor pedals, pull the pit pins at the base of the tail rotor pedal pedestals and slide the pedestals and pedals out of the sockets. To remove the cyclic, remove the safety pin and unscrew the knurled knob at the base and pull the cyclic free. Unplug the wire bundle from the junction box on the right rear cabin wall. Cover the exposed plugs with the cap furnished with the box. To remove the collective, pull the pit pin at the base, slide the collective forward out of its socket, unplug the wire bundle from the right rear wall cabin junction box. Install cyclic and tail rotor socket covers. To re-install, reverse the process.

7-11. Instruments and Controls

a. Instrument Panel. The standard location of controls, indicators, instruments, and data placards installed on the instrument panel is presented in Figure 7-3. The total instrument complement and location may vary depending upon the specific aircraft options.

b. Pedestal Panel. The panels and controls installed in the radio pedestal are presented in Figure 7-3.1.

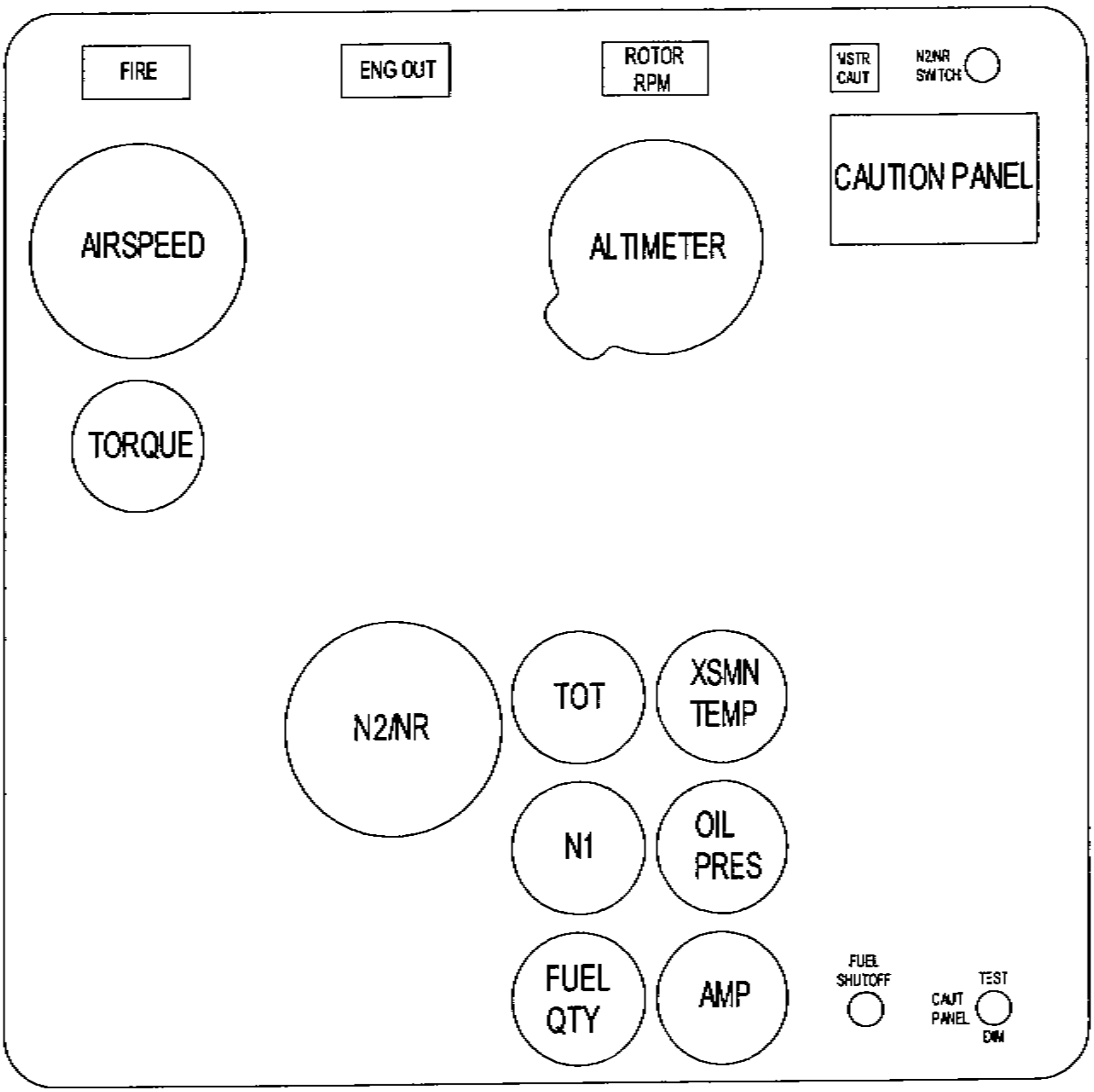
c. Other Instruments and Controls. Instruments, controls, and indicators not shown in the above illustrations are shown in the chapter/section which describes their related systems.



Standard Panel - Standard Instrumentation

Sheet 1 of 2

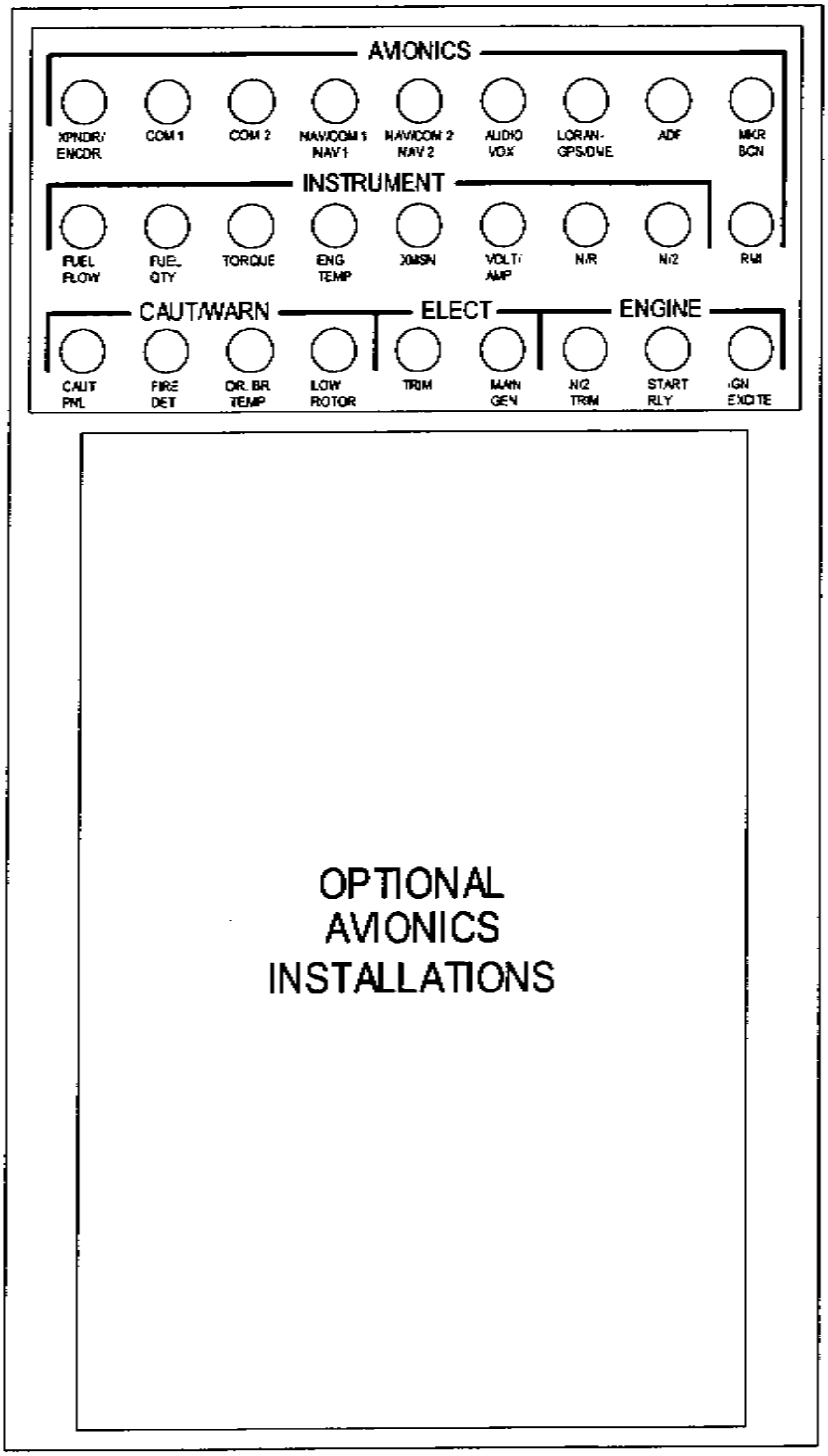
Figure 7-3. Instrument Panel



Optional Panel - Standard Instrumentation

Sheet 2 of 2

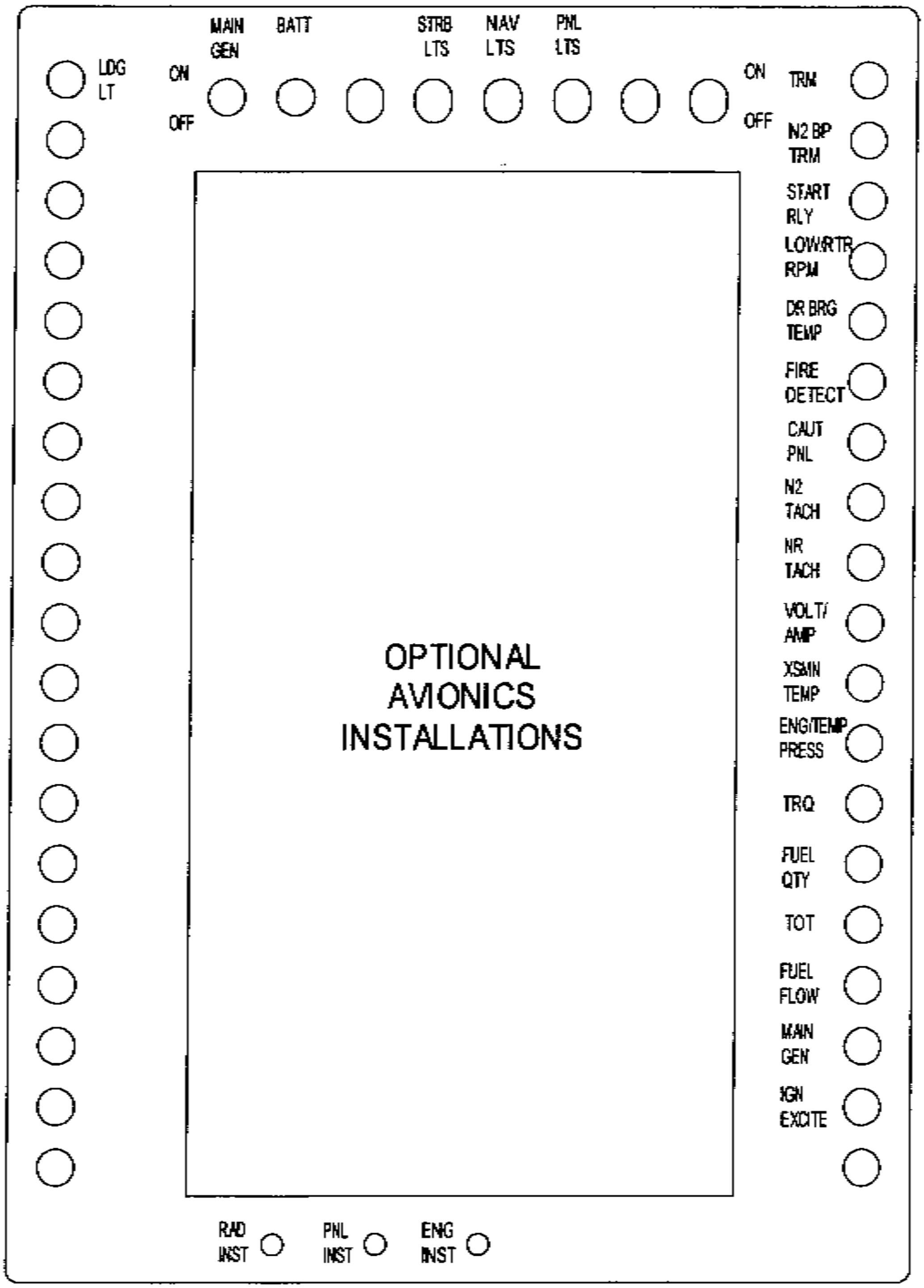
Figure 7-3. Instrument Panel



Standard Panel - Standard Layout

Sheet 1 of 2

Figure 7-3.1. Pedestal Panel



Optional Panel - Standard Layout

Sheet 2 of 2

Figure 7-3.1. Pedestal Panel

SECTION II. EMERGENCY EQUIPMENT

7-12. Portable Fire Extinguisher A portable fire extinguisher is carried in a bracket located on the floor to the left of the pilot seat.

7-13. Aircraft Fire Detection System

a. General. The 480 is equipped with a Systron Donner fire detection system consisting of a test switch, a fire/overheat detector, and a red **FIRE** warning light on the instrument panel. The system provides the flight crew with the necessary warning of fire or excessive overheat in either the upper or lower engine compartments. The system is powered by the aircraft 28-volt electrical system and is protected by the **FIRE** circuit breaker.

b. Fire/Overheat Detector System. The aircraft is equipped with a Systron Donner model 801-DRH pneumatically operated fire/overheat detector system. The System consists of a sensor tube, a responder assembly, and separate test and annunciator circuits. The detector sensor tube contains helium gas under a preset pressure and a hydrogen charged core material. The application of heat to the sensor causes an increase in internal gas pressure which in turn operates a pressure diaphragm within the responder assembly that closes an electrical contact activating the red cockpit **FIRE** warning light at the top of the instrument panel. The pressure diaphragm within the responder assembly serves as one side of the electrical contact and is the only moving part in the detector. Mechanical damage to the pneumatic detector's sensor tube cannot result in a false alarm. Any severe damage or deterioration to the unit will provide a "no test", not a false alarm. Also, because of the action of an electrical shunt plate installed at the mating face of the responder connector, the intrusion of conducting fluids into the electrical connector cannot cause a false alarm.

(1). Averaging and Discrete Sensing Functions. The detector has two sensing functions. It responds to an overall "average" temperature threshold or to a highly localized "discrete" temperature caused by impinging flame or hot gasses. Both the "average " and "discrete" temperatures are factory set and cannot be changed in the field. Both the averaging and the discrete functions are reversible. When the sensor tube is cooled, the pressure is lowered and the reduction of internal pressure allows the alarm switch to return to its normal position thus opening the electrical alarm circuit.

(2). Detector Test Function. In addition to the pressure activated alarm switch, there is a second switch in the detector which is held closed by the averaging gas pressure at all temperatures down to -65 degrees F. If the detector should develop a leak, the loss of gas pressure would allow the integrity switch to open and signal a lack of detector integrity by inhibiting the test function. The crew may test the detector system by pressing the Caution Panel test switch down and holding it. A lack of detector integrity would prevent the **FIRE** warning light from activating. A properly functioning system will be annunciated by the **FIRE** warning light on the instrument panel illuminating as long as the test switch is held. The detector sensor will withstand an 1100 degree C direct flame without deterioration for 5 minutes.

7-14. First Aid Kit One general purpose first aid kit is provided in the cabin area.

SECTION III. ENGINE AND RELATED SYSTEMS

7-15. Engine

The 480 is equipped with an Rolls-Royce 250-C20W free turbine, turboshaft engine rated at 420 SHP but derated in this installation to 285 SHP for a five minute takeoff rating, and 256 SHP for maximum continuous operation.

7-16. Engine Components

The engine consists of four sections: the compressor section, the combustor section, the turbine section, and the power and accessory gearbox.

a. Compressor Section. Air enters the engine through the compressor inlet and is compressed by six axial and one centrifugal compressor stages. The compressed air is discharged through the scroll-type diffuser into two external air ducts which convey the air to the combustion section.

b. Combustor Section. The engine has a single combustion chamber. Air from the compressor discharge tubes enters the single combustion chamber at the aft end. The air is mixed with fuel sprayed from the fuel nozzle and the combustion takes place. Combustion gasses move forward out of the liner to the two stage gas producer turbine.

c. Turbine Section. The turbine section is mounted between the combustion section and the power and accessory gearbox and consists of a two stage power turbine and a separate two stage compressor turbine. The compressor turbine drives the compressor and accessories gear train while the power turbine furnishes the output power of the engine through the power gear train. The hot exhaust gases discharge downward through twin ducts in the turbine and exhaust collector support.

d. Power and Accessory Gearbox. The main power and accessory drive gear trains are enclosed in a single gear case. The gear case serves as the structural support of the engine. All engine components, including the engine mounted accessories are attached to the case. Accessories driven by the power turbine gear train are the power turbine tachometer generator and the power turbine governor. The gas producer gear train drives the compressor, fuel pump, gas producer tachometer generator, gas producer fuel control, and the starter-generator.

7-17. Engine Compartment Cooling

The engine compartment is cooled by natural convection augmented by a fan integral to the upper drive pulley.

7-18. Air Induction System

The aircraft is equipped with dual full flow swirl tube inertial type particle separators. Particle laden air is directed into the upper plenum chamber through a series of swirl tubes which impart a centrifugal spin to the air as it enters the tubes, thereby inertially separating the heavier foreign matter. The particulate matter falls down into a collector and is then purged overboard through one of two bleed air driven venturi-type ejectors that exit at the aft face of the upper plenum. The scavenge ejectors are manually controlled by a handle mounted on the aft side of the center pedestal. During takeoff, hovering, or cruise operations in dusty atmospheric conditions the scavenge ejectors can be turned on by moving the **SCAV AIR** control to the **ON** position (Figure 7-3.2).

7-19. Engine Inlet Air Caution Light

The **ENG INLET AIR** caution light is a part of the segmented caution panel and will illuminate any time there is a pressure drop of at least 0.5 psi across the inlet indicating that there is a partial blockage of the particle separator. This caution light is activated by a differential pressure switch which senses air pressure in the lower plenum and compares it to reference pressure at static ports on either side of the tailcone. Pilot action required when this caution light illuminates is discussed in the Chapter 3 Emergency Procedures section of this manual.

7-20. Engine Inlet Anti-icing System

The compressor inlet guide vanes and the front bearing support hub are the only engine components with anti-icing provisions. Anti-icing is provided by the use of compressor bleed air. Anti-icing is activated by moving the **ANTI-ICE** control located on the aft side of the center pedestal to the **ON** position (Figure 7-3.2).

7-21. Engine Fuel Control

The C20W engine has a Bendix fuel

control installed. The system controls engine power output by controlling the gas producer speed. Gas producer speed levels are established by the action of the power turbine fuel governor which senses power turbine speed. The power turbine speed (load) is selected by the operator and the power to maintain this speed is automatically maintained by power turbine governor action on metered fuel flow. The power turbine governor lever schedules the power turbine governor requirements. The power turbine governor in turn, schedules the gas producer speed to a changed power output to maintain output shaft speed.

a. Throttle. The throttle is a twist grip type on the collective flight control. The throttle is rotated to the left to increase or to the right to decrease power.

b. Engine Idle Release Control. The engine idle release is a spring loaded plunger mounted in the switch box on the pilot's collective. The plunger prevents the pilot from accidentally retarding the throttle beyond the engine idle position. This acts as a safety feature by preventing inadvertent engine shutdown. The plunger need not be depressed when performing engine start or runup, however, the plunger must be depressed when accomplishing an engine shutdown.

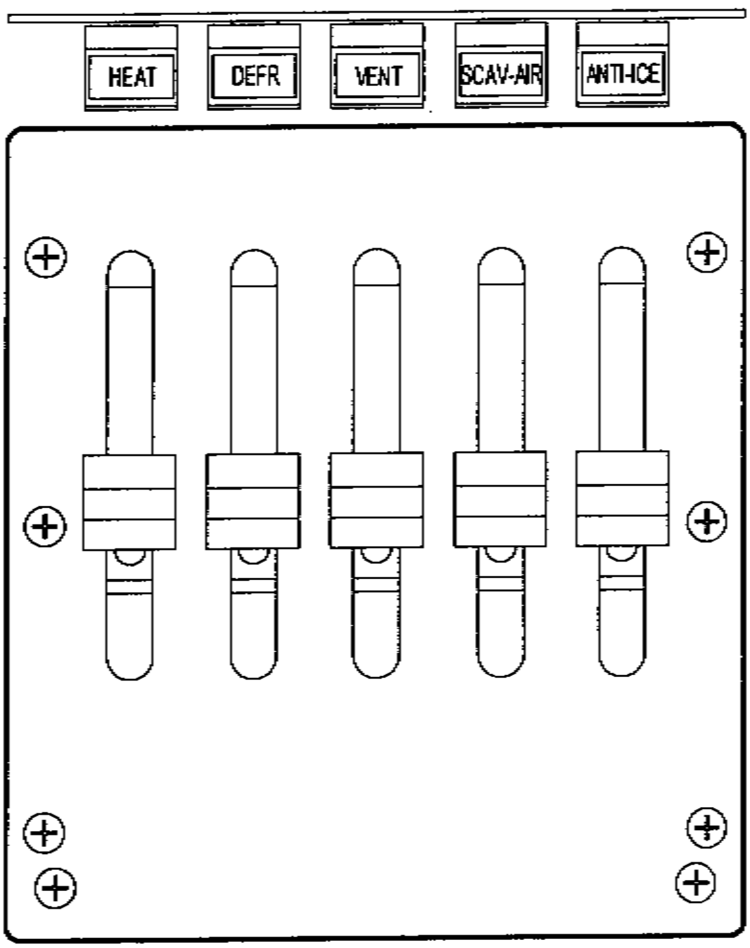
c. Governor RPM Beep Trim Switch. The **GOV INCR/DECR** switch is mounted in the switch box on both the pilot's and the copilot's collective controls. The switch is a three position momentary type. The switch must be held in the forward (**INCR**) position to increase the power turbine (**N2**) speed or in the aft (**DECR**) position to decrease the power turbine (**N2**) speed. Regulated power turbine speed may be adjusted in flight through the operating range by movement of the switch as required. Electrical power for circuit operation is supplied by the 28-volt electrical system.

d. Gas Producer Fuel Control. The Bendix gas producer fuel control has a bypass valve, metering valve, acceleration bellows, governing and enrichment bellows, manually operated cutoff valve, maximum pressure relief valve, a torque tube seal and lever assembly and a start derichment valve. The maximum pressure relief valve is incorporated to protect the system from excessive fuel pressure. Fuel enters the control from the engine driven fuel pump and filter assembly and is conveyed to the metering valve. The metering valve is operated by lever action through movement of the governor and acceleration bellows. The start derichment valve is only open during lightoff and acceleration to idle. Gas producer speed is controlled by the gas producer fuel control governor. The governor reset section of the gas producer fuel control, however, permits the power turbine governor to override the speed governing elements of the fuel control to alter the fuel schedule in response to changing load conditions applied to the power turbine. The start/acceleration control is provided as an adjustable control to allow maintenance personnel to adjust the start cycle for altitude or temperature.

e. Power Turbine Governor. The power turbine speed is scheduled by the power turbine governor lever and the power turbine speed scheduling cam. The cam sets a governor spring load which opposes a speed-weight output. The overspeed protection of the compound power turbine governor becomes effective at approximately 108% N2.

f. Fuel Pump and Filter Assembly. The C20W incorporates a single gear-type pumping element, a low pressure barrier filter and a filter bypass valve. Fuel enters the engine fuel system at the inlet port of the pump and passes through the low pressure filter before entering the gear element. The filter bypass valve allows fuel to bypass the filter element if it becomes clogged. The bypass return flow from the fuel control is passed back to the inlet of the gear element. Through passages leading to auxiliary filling ports on the periphery of the gear element, a portion of the bypass flow fills the gear teeth when vapor-liquid conditions exist at the inlet to the gear element. The nominal paper filter is located inside the fuel pump assembly upstream of the gear element. It is retained by a cast cover attached to the pump housing by two socket head cap screws. The cover is located on the rear of the pump.

g. Fuel Nozzle. The fuel nozzle is a single-entry dual-orifice type unit which contains an integral valve for dividing primary and secondary flow. This same valve acts as a fuel shutoff valve when the fuel manifold pressure falls below a predetermined pressure, thus keeping fuel out of the combustion chamber at shutdown.



NOTES

1. MOVE CONTROL UP FOR "ON" AND DOWN FOR "OFF"

2. CONTROLS ARE ON SIDE OF CENTER PEDESTAL FOR S/N 5001

3. "HEAT", "DEFR", AND "VENT" ARE OPTIONAL EQUIPMENT. LOCATION OF "SCAV-AIR" AND "ANTI-ICE" MAY VARY DEPENDING ON CUSTOMER SPECIFICATION.

Figure 7-3.2. Slide Control Panel

7-22. Fuel Filter Caution Light

A fuel filter differential pressure switch is installed at the fuel filter element to measure filter pressure drop. When the pressure drop exceeds 1.3 PSID the switch will activate the **FUEL FILTER** caution light on the segmented caution panel to alert the pilot to impending filter bypass. Pilot action when this light is illuminated is addressed in Chapter 3 Emergency Procedures.

7-23. Turbine Outlet Temperature (TOT) Measurement System

The TOT measurement system consists of four chromel-alumel, single junction thermocouples in the gas producer turbine outlet with an integral terminal. The voltages of the four thermocouples are electrically averaged in the assembly and delivered by the assembly lead to the airframe terminal block for reference to the airframe temperature indicating system.

7-24. Compressor Bleed Air System

The 5th stage bleed air system permits rapid engine response. The system consists of a compressor discharge pressure sensing port on the scroll, tubing from the sensing port to the bleed valve, a compressor bleed control valve and a bleed air manifold on the compressor case. An annular slot over the 5th stage blades bleeds compressor air into a manifold which is an integral part of the compressor case. The manifold forms the mounting flange for the compressor bleed control valve when the compressor case halves are assembled. Compressor discharge air pressure sensing for bleed control valve operation is obtained at a sensing port on the compressor scroll. The bleed control valve is normally open until 73% N1 and is closed by compressor discharge pressure slowly until reaching fully closed at approximately 93% N1 at sea level standard conditions. The values where the bleed air valve starts to close and is fully closed will vary with altitude and temperature.

7-25. Ignition and Start System

The starter switch, located in the switch box on the pilot's collective is a pushbutton type switch. When the switch is pressed, the circuit to the starter relay actuating coil and the igniter unit are energized. The switch is released when the engine starts or the starter time limit expires. The circuit is protected by the **START RLY** and **IGN EXCTR** circuit breakers.

7-26. Engine Oil Supply

The lubrication system is a circulating dry sump type with an external reservoir, scavenge filter and heat exchanger. A gear-type pressure and scavenge pump assembly is mounted within the gearbox. The oil filter, filter bypass valve, and pressure regulating valve are located in the lower right hand side of the gearbox housing and are accessible from the bottom of the engine. The engine oil tank is located on the right side of the aircraft in the upper engine compartment where it is easily accessible for preflight and servicing through the right hand engine compartment access panel. The tank has a capacity of 12 pints (1.5 gallons). The engine oil cooler is upstream of the reservoir. The oil passes through the oil cooler heat exchanger and is cooled by air supplied by a high volume oil cooler blower. An external scavange oil filter is installed between the oil cooler and the engine. All engine oil system lines and connections are internal except the pressure and scavenge lines to the front compressor bearing and the bearings in the gas producer and power turbine supports.

7-27. Engine Chip Caution Light

Indicating type magnetic chip detectors (drain plugs) are installed at the bottom of the gearbox and at the engine oil outlet connection. Both engine chip detectors are of the non-fuzz burning type, are connected in parallel, and incorporate a Programmable Continuity Sensor (PCS). Any time power is applied to the segmented caution panel or the caution panel test switch is pressed and held for at least 3 seconds, the PCS will go through a 5 second continuity check to ensure that the circuit is complete. During that time the **ENG CHIP** caution light will remain illuminated then extinguish. If there is a break anywhere in the circuit the caution light will not respond to the 5 second test. During normal operation, any chip detected on either plug will activate the **ENG CHIP** caution light on the segmented caution panel.

7-28. Engine Instruments and Indicators

The engine instruments and indicators are mounted in the instrument panel or the segmented caution panel. They are described in the following paragraphs and are shown in Section II of chapter 1.

a. Engine Out Warning. The segmented caution panel logic circuit senses the output from the gas producer tachometer generator. Power is supplied through the **CAUT/PNL** circuit breaker and connections are made to the **ENGINE OUT** warning light and to a tone generator which produces an oscillating tone. The warning system is activated until the N_1 reaches 58% +/- 1% and is deactivated when the gas producer speed is above that value. The engine out audio is distinctly different from the low rotor audio and when activated the engine out audio tone generator produces an oscillating warble tone.

b. Audio Warning Microswitch. An audio warning microswitch is installed in the collective control system. This switch enables the pilot to disable the audio signal by lowering the collective to the full down position. The audio microswitch is located at the base of the pilot's collective.

c. Torquemeter. The engine torquemeter, located in the instrument panel, is driven by an engine mounted pressure transducer, and is powered by the aircraft 28-volt electrical system through the **TORQUE** circuit breaker.

d. Turbine Outlet Temperature (TOT). Two types of turbine outlet temperature indicators are used in the 480. The "Passive" indicator directly uses the DC voltage produced by the engine thermocouple harness. This voltage is displayed as temperature on the TOT indicator. No external power is required for the "Passive" indicator. The "Active" indicator uses the same DC voltage produced by the engine thermocouple harness. The "active" indicator, which is powered by the aircraft 28-volt electrical system through the **TOT** circuit breaker, then converts the DC voltage through filters into a signal which drives the indicator pointer to show the turbine outlet temperature. The "active" indicator will not operate without 28-volt electrical power. In the event of a main electrical bus failure, the instrument can be driven directly from the aircraft battery by moving the "N2-NR-TOT" switch from "MAIN BUSS" to "BATT BUSS".

NOTE

The N2/NR Switch will only be labeled "N2-NR-TOT" when an "Active" TOT indicator is installed in the aircraft.

e. Gas Producer Tachometer. The gas producer tachometer generator, located on the engine, generates an AC voltage with a frequency that is a function of the gas producer turbine (N_1) RPM. The electrical output of the tachometer generator is used to drive a similar electric motor within the gas producer indicator which in turn indicates the frequency in terms of percent RPM of the gas producer turbine speed. The power for the gas producer tachometer is engine generated and does not depend on the aircraft electrical system.

f. Power Turbine Tachometer. The power turbine tachometer is a part of the dual tachometer indicator located on the instrument panel. This is a digital system, powered by the aircraft 28-volt electrical system through the **N2** circuit breaker, and driven by either a Hall Effect tachometer generator that generates pulses that are a function of the power turbine (N_2) RPM or a tachometer generator which generates an AC voltage with a frequency that is a function of the power turbine (N_2) RPM. The pulses or AC voltage are then used to drive a stepper motor within the indicator which in turn positions the power turbine RPM pointer (marked "T") to indicate the percent RPM of the power turbine on the outer scale of the dual tachometer indicator. Because this is a digital system, the RPM of the power turbine is changed to a digital pulse and then remains a digital value when it is displayed to the pilot. The system has a 0.5% resolution and system accuracy. Therefore as the needle moves it will appear to step from one value to the next rather than present a smooth movement as would normally be expected from the usual analog type display. The advantage of this system over the traditional analog display is its accuracy and reliability over the life of the instrument. The instrument goes through a self calibration cycle every time power is applied thus assuring that the calibrated system accuracy is stable for the life of the instrument. This system requires 28 VDC for operation. In the event of a main electrical bus failure, the instrument can be driven directly from the aircraft battery by moving the "N2/NR" switch from "MAIN BUSS" to "BATT BUSS".

g. Dual Engine Oil Temperature and Pressure Gage. The engine oil pressure is displayed on the right half of the dual oil pressure / temperature indicator located on the instrument panel. The oil pressure display is driven by an engine mounted oil pressure transducer. The oil temperature is displayed on the left half of the same

Indicator and is driven by a remote sensing thermocouple located at the engine oil tank outlet. The dual indicating instrument is powered by the aircraft 28-volt electrical system through the **ENG T/P** circuit breaker.

h. Caution Lights.

(1) The **ENG INLET** caution light is discussed in the air induction system section, paragraph 7-19.

(2) The **FUEL FILTER** caution light is discussed in paragraph 7-22.

(3) The **ENG CHIP** caution light is discussed in paragraph 7-27.

(4) The **ENG OIL TEMP** caution light will illuminate when the engine oil temperature reaches 107°C ascending and will extinguish at 100° descending. A set of contact closures in the dual engine oil temperature/pressure indicator send a signal to the segmented caution panel logic circuit at each of the above set points to turn the caution light either on or off accordingly.

(5) The **ENG OIL PRESS** caution light will illuminate if the N1 is above 78.5% and the oil pressure is at or below 88 psig. The light will extinguish as the pressure rises above 90 psig with the N1 above 78.5%. For helicopters equipped with P/N ECD4078 caution panel, the **ENG OIL PRESS** caution light will also illuminate anytime engine oil pressure is below 50 psi or above 130 psi.

SECTION IV. FUEL SYSTEM

7-29. Fuel Supply System

The helicopter is equipped with either "standard" fuel bladders or "crashworthy" fuel bladders designed to retain fuel in a crash and to minimize fuel spillage should the tanks separate from the aircraft or the lines separate from the fuel cells. The system shown in Figure 7.4 consists of two 45 gallon bladder type fuel cells mounted either side of the main rotor transmission. Each bladder is housed in a composite fuel cell structure and is interconnected to the other bladder through a 2.0 inch crossfeed line in the lower 1/3 of the fuel cell and a 1/2 inch overboard vent line. A 3/4 inch main fuel feed line from the lowest point in each bladder interconnects through the main fuel shutoff valve in a "tee" to provide the fuel to the engine equally from each cell. The main fuel shutoff valve is a ball type valve manually operated from the cockpit. It is activated by pushing the center button in and holding it in while pulling the knob fully out until it stops, approximately a 4 inch pull. Each fuel cell is equipped with sump drains plus the system is equipped with a low point drain before the fuel enters the engine. The capacitance fuel quantity probe is mounted in the right hand fuel cell. The fuel filler cap is located in the top of the left hand fuel cell. The right hand cell is filled by crossfeeding action during gravity refueling.

7-30. Fuel Quantity and Management System (optional).

a. General. The optional fuel management system consists of a fuel flow transducer and display unit. In addition to displaying the calculated fuel quantity in pounds, the system displays instantaneous fuel flow in pounds per hour, displays instantaneous endurance in terms of hours and minutes of flight time available at the current fuel flow, and displays fuel consumed in pounds. Additionally, if an optional Loran/GPS system is installed, the fuel management system can provide the Loran/GPS system with real time fuel flow and fuel remaining through a serial port.

NOTE

Refer to the Loran/GPS Operation Manual for the system functions, capabilities, and operating instructions.

b. Fuel Flow and Endurance Displays. The cockpit fuel flow and endurance display is mounted in the center of the instrument panel and consists of a six-segment digital display. The left three segments of the digital display are dedicated to fuel flow in pounds per hour based on 6.7 lb/gallon fuel density. The right-most three segments are switchable between displaying fuel endurance in hours and minutes, based on current fuel flow or fuel remaining, or fuel used in pounds.

NOTE

The total fuel quantity on board in this display system is not automatically sensed by a fuel quantity probe. it must be manually loaded by the pilot at each refueling by noting the quantity displayed on the analog fuel quantity gage and then loading that value into the digital display.

7-30.1. Fuel Quantity System.

The capacitance probe located in the right fuel cell senses and reports actual fuel quantity on board by measuring the height of the fuel electronically and then displaying that quantity on the analog fuel quantity gage.

NOTE

The analog fuel quantity display is the primary source of fuel quantity information because it is a direct reading gage from the capacitance probe. If there is a discrepancy between the digital and analog display of fuel remaining the pilot should rely only on the analog display.

a. Low Fuel Caution Light. The low fuel caution light system consists of a float switch located near the capacitance fuel quantity probe. This switch activates the LOW FUEL light in the segmented caution panel when there are approximately five gallons of fuel or less remaining.

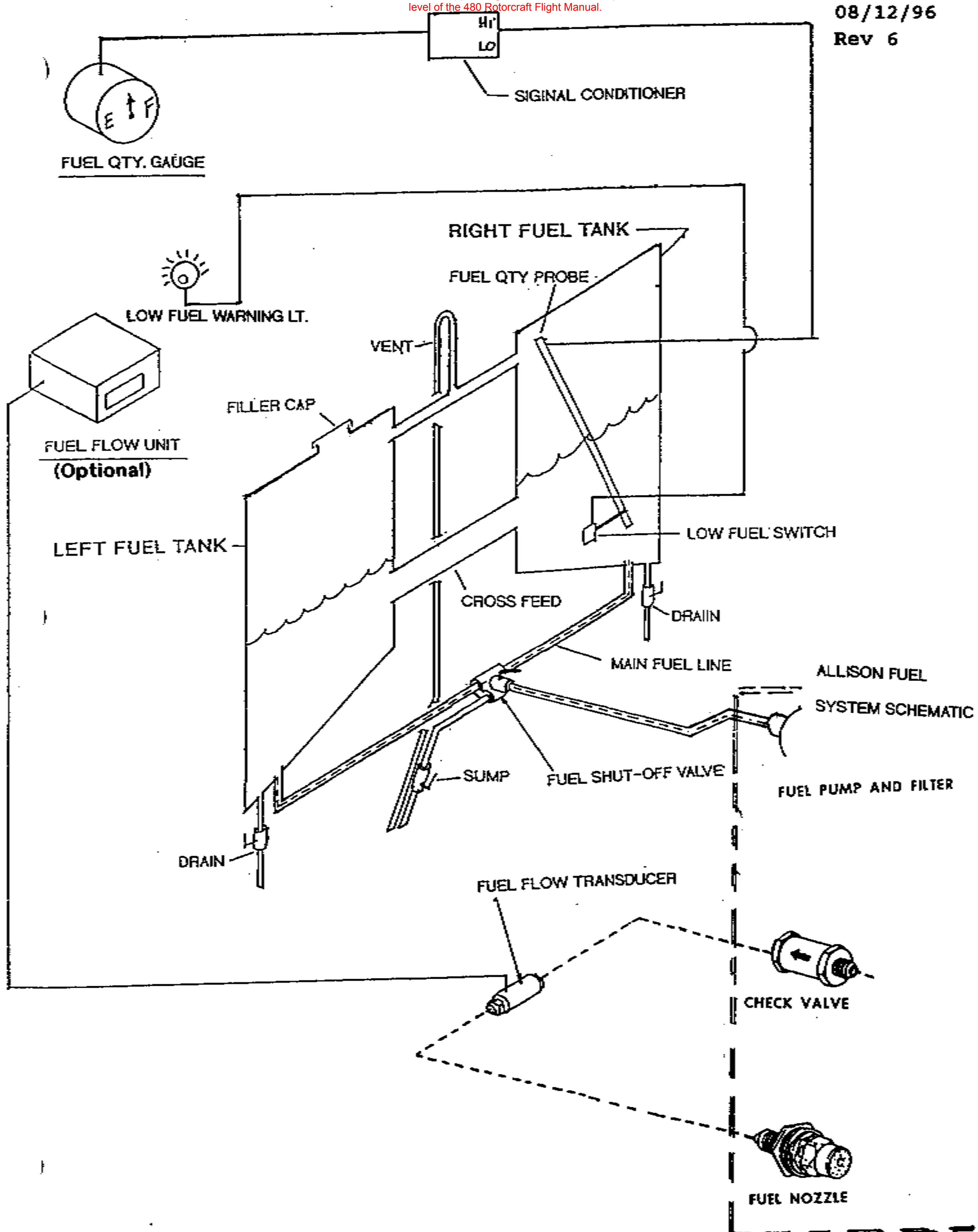


Figure 7.4 Fuel System Diagram

7-31. Description

The flight control system includes three primary systems: the collective, cyclic, and anti-torque or directional controls. The aircraft also has fixed horizontal and vertical stabilizers mounted on the tailboom to provide additional stability and attitude control during high speed flight.

7-32. Collective Pitch Control System

The collective pitch control system includes dual collective controls mechanically interconnected and linked to the main rotor swashplate through a series of push-pull tubes, torque tubes, bellcranks, and a collective walking beam at the base of the main rotor transmission. Both collective controls have interconnected twist grip throttles installed at the forward end of the control stick and each has a switch box mounted forward of the throttle. Only the pilot's collective incorporates a mechanical idle stop release plunger between the forward end of the throttle and the collective switch box and a collective friction control located mid collective on the outboard side. The copilot's collective switchbox contains only two switches; a landing light attitude control switch, and an N_2 power turbine governor "beep trim" control switch. The pilot's collective switchbox incorporates all of the switches found on the copilot's collective plus an engine start-ignition switch and a landing light on/off switch. No throttle friction exists for either collective. The right (co-pilot's) collective is removable.

7-33. Collective Friction

The collective friction system consists of a simple slider that incorporates both the up and down collective pitch stops and a knurled knob and lever used to clamp two friction disks to the slider bar. When the lever attached to the knurled knob is pointing straight at the floor the friction is completely removed. Collective friction is fully applied when the lever is approximately aligned with the collective control. Total movement of the collective friction lever from full “on” to full “off” is approximately 100°. The control may be positioned on any intermediate position for any desired level of friction.

CAUTION

The collective friction mechanism is designed so that positive locking of the collective controls cannot be obtained at the maximum friction point. Safety of flight considerations require that the pilot be able to instantly overcome the established friction without any further pilot action to adjust it in the case of engine failure. Once friction has been applied the pilot should always check to ensure that it can be overcome by making a small collective movement to test it. If there is too much resistance, reset the friction lever to where it is satisfactory and make an entry in the maintenance logs to have the ground maintenance crews readjust the friction.

7-34. Cyclic Pitch Control System

a. General Description. The cyclic pitch control system is a fully mechanical control system which is linked to the swashplate through a series of interconnected push-pull tubes, torque tubes, and bellcranks. Both longitudinal and lateral control systems are totally independent with no intermixing before the individual inputs reach the swashplate. Non-rotating control inputs are transmitted to the rotating controls via a universal joint type swashplate at the base of the transmission. Inputs are mixed at the swashplate and transmitted through a set of three long push-pull tubes through the center of the mast to pitch change bellcranks at the top of the hub and then through pitch change links to the blade pitch horns located on the leading edge of each blade. Cyclic control position is maintained and rotor feedback forces are reduced to zero through a dual acting jack-screw trim actuator installed in each control axis and located on the backwall of the cabin. Some aircraft may also have vibration absorber beams installed on the upper lateral and longitudinal bellcranks located in the engine compartment. These beams reduce the mechanical feedback vibration felt in the cyclic controls caused by the main rotor blades.

b. Cyclic Control. The aircraft is equipped with two cyclic sticks, each located directly in front of the respective pilot and copilot seats. The right hand cyclic is removable at floor level. The two sticks are mechanically interconnected so that the movement of one stick moves the other stick simultaneously. The switches mounted on each cyclic grip assembly control the systems marked by each switch on the grip. The "coolie hat" four way toggle switch (momentary contact) at the top center of the grip is used to control the four way cyclic control trim system. The two detent (momentary contact) ICS/Radio trigger switch located on the forward face of the grip is used to transmit on ICS (optional equipment)or on the selected communications radio (optional equipment). Each of the red push button switches can provide the pilot remote control of frequency selection on the communications or navigation radio or other functions depending on the optional equipment installed.

c. Cyclic Trim Control. Cyclic trim control consists of a cyclic trim switch located at the top of each cyclic grip, a pair of electrically operated jack screw actuators that vary spring tension produced by the longitudinal and lateral trim units, and various connecting linkage. The cyclic trim switches each have five positions which are: normally OFF in the center, and momentary FORWARD, AFT, LEFT, and RIGHT. Both trim mechanisms include an electrically operated reversible motor and a cylindrical spring assembly connected to the cyclic control linkage and both are mounted on the cabin backwall in the upper engine compartment. When a trim switch is moved off center to any one of the four trim directions, 28-volt, direct current power from the aircraft's electrical system, through the **TRIM** circuit breaker, energizes one of the trim motors to apply trim spring force in the desired direction. By momentarily moving the switch, very small trim increments may be obtained. Trim forces cannot be applied in two directions simultaneously; when both longitudinal and lateral trim corrections are desired, it is necessary to apply first one and then the other. The cyclic trim mechanism does not limit travel of the cyclic control; the pilot may override the trim forces at any time.

This type of trim system has been installed because there is no hydraulic system to block the normal feedback of rotor forces to the cyclic. Without any trim in either the longitudinal or lateral cyclic control system, as the helicopter accelerates into flight in any direction from a stabilized hover the pilot would have to counter the normal rotor reaction to increase in airspeed by holding rather significant cyclic forces in the direction of flight. The trim system allows the pilot to re-establish a new zero cyclic force trim point as the helicopter is maneuvered throughout its flight envelope thereby maintaining very low cyclic forces and thus workload. Because the cyclic control inputs are not mixed until they reach the swashplate, the pilot will experience the rotor aerodynamic force feedback as it occurs at the rotor. Therefore, as the helicopter accelerates into forward flight he will experience a requirement to trim first forward and then more predominantly to the right as airspeed builds and vice versa as the airspeed decreases. In addition, in stabilized forward flight, deviations from a trimmed condition at a given airspeed will be most immediately noticed by the pilot as a requirement for lateral retrimming as the airspeed increases or decreases, followed by a requirement to retrim in the longitudinal axis as the lateral forces are zeroed. The ratio of the lateral force to longitudinal force feedback into the cyclic is on the order of three to one. Thus the pilot will almost always experience the highest trimming activity in the lateral axis as the helicopter is maneuvered. Since the rotor force feedback is significant, the trim unit forces to counter the rotor forces must, of necessity, be fairly high also. Therefore, if the pilot chooses not to retrim during maneuvers or accelerations and decelerations of the helicopter, he will be forced to supply rather significant force at the cyclic. A preferred method of flying this type of fully reversible control system is to lead the cyclic movement with trim. In this manner the trim motors do all of the work and the pilot must then only supply small force input to make the final adjustment to achieve the desired cyclic position as the helicopter is maneuvered.

7-35. Tail Rotor (Antitorque) Control System

a. General. The tail rotor control system provides directional control of the aircraft by varying the pitch in the tail rotor blades. Depressing either of the antitorque pedals moves a system of bellcranks and control cables that travel through the tailcone to the tail rotor assembly.

b. Antitorque Pedals. The antitorque control pedals are located on the floor directly in front of the pilot's and copilot's seats. The right-hand set of pedals can be removed at floor level. Pushing forward on the left pedal changes the aircraft heading toward the left, and pushing forward on the right pedal changes the aircraft heading toward the right. A full 8 inches of pedal adjustment is available, to suit the individual pilot, by removing the quick release pins located at the top of the pedestal arms, repositioning the pedals and reinstalling the pins. There are two slots available for adjustment on the top of each pedestal arm, one horizontal and one angled. The pilot may select either corresponding pair to hold the pedals so that the pedal bar can be positioned under the desired area of the boot or shoe for ease of pedal movement.

SECTION VI. POWER TRAIN

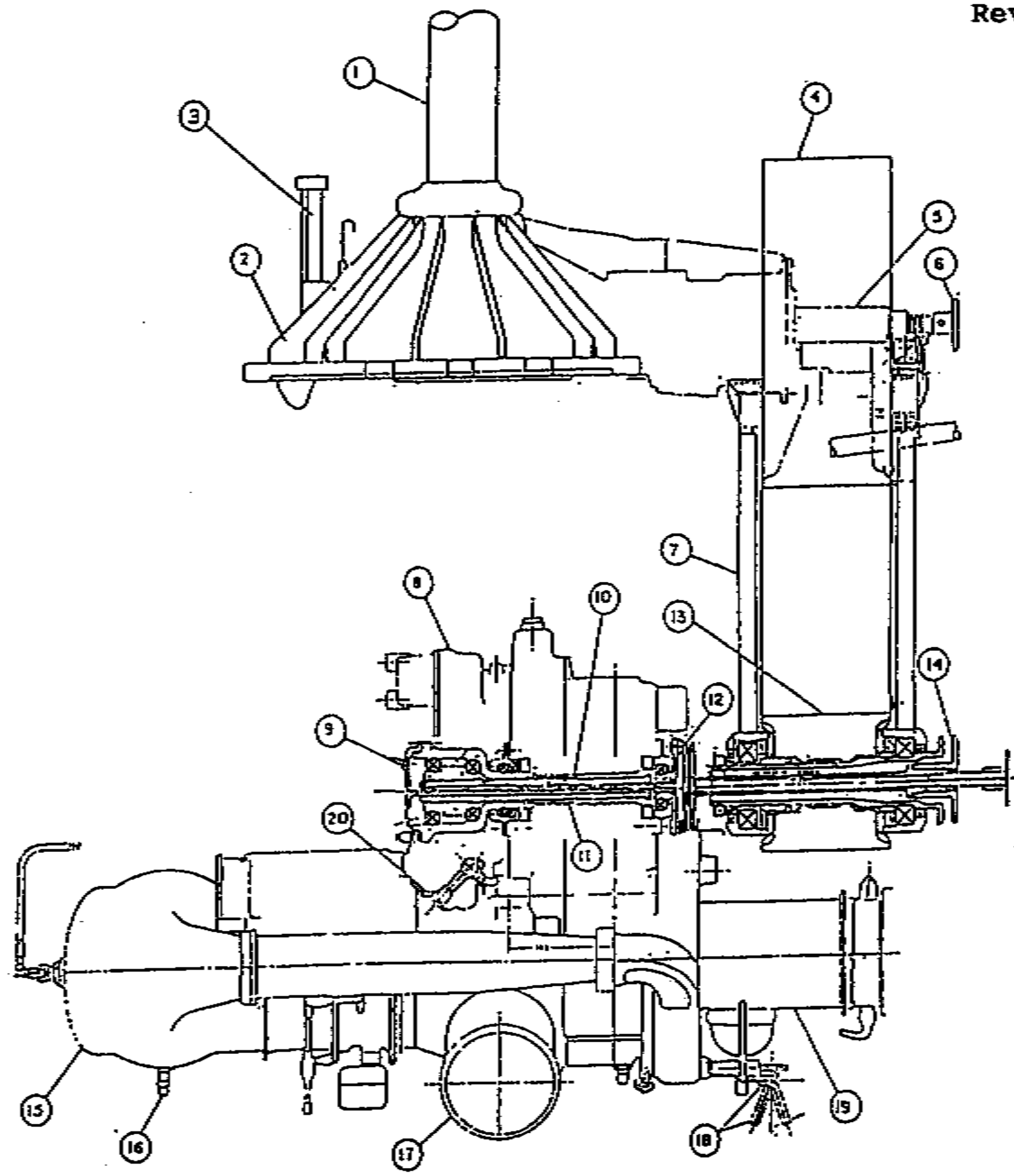
7-36. General Description The power train shown in Figure 7-6 includes the main rotor transmission, upper pulley, kevlar backed drive belt, lower pulley, lower pulley drive shaft, high speed freewheeling drive unit, high speed splined power output drive shaft, short tail rotor drive shaft, long tail rotor drive shaft, and the tail rotor gearbox.

7-37. Main Rotor Transmission The main rotor transmission is a splash lubricated ring and pinion geared transmission that changes the direction of drive, reduces the rotational speed by a 7.154 to 1 gear ratio, and transmits all of the lifting and flight loads of the main rotor to the pylon. An oil level sight gage is located on the right rear of the transmission and can be viewed by looking between the blades of the upper pulley fan below the right rear of the upper plenum chamber. A bayonet type chip detector installed in the drain plug is incorporated. Starting with 480 Serial Number 5042, the main rotor transmission is equipped with an oil filtration/cooling system. This system consists of a heat exchanger, an electric pump, a pressure switch, a filter assembly, connecting oil lines, and the mounting brackets and hardware. The heat exchanger is located on the transmission forward of the upper pulley assembly. The electric pump is a 24 Vdc unit powered through the **MRGB PUMP** circuit breaker and located on the left side of the pinion area of the transmission. The pressure switch is installed between the heat exchanger and the inlet port of the pump. The pressure switch controls a segment light (MRGB PRESS) in the caution panel that indicates when the pump inlet pressure is less than 4.4-5.9 psi/30.2-40.7 kPa of vacuum. The filter assembly, located at the left aft area on the bottom of the transmission, incorporates a 10-12 micron spin-on oil filter. The filter assembly also incorporates the chip detector and a check valve that is used to prevent loss of oil in the transmission due to a break in the system between the filter housing outlet and the pump inlet. The oil filtration/cooling system does not provide pressure lubrication for the main rotor transmission; failure of the pump does not adversely effect the lubrication of the main rotor transmission. Total oil capacity in the transmission is 6 pints/2.84 liters, total capacity is 6.5 pints/3.1 liters if equipped with the filtration/cooling system.

7-38. Tail Rotor Transmission The tail rotor transmission, mounted at the aft end of the tailboom on the stringer tube, supports and drives the tail rotor assembly. The tail rotor transmission is a splash lubricated, closed oil system with a filler port, no breather, a sight gage located on the aft end of the transmission, and a chip detector installed in the drain plug. The total oil capacity of the tail rotor transmission is five ounces.

7-39. Tail Rotor Drive Shaft The tail rotor drive shaft is a two section drive shaft connected to each other and the main and tail rotor transmissions by means of six bolt flex couplings comprised of multiple thin stainless steel plates bolted to the coupling drive flanges. These drive couplings permit the normal small angular misalignment caused by tail rotor thrust and aerodynamic loading on the tailboom. The short section of drive shaft directly aft of the upper pulley connects the main rotor transmission pinion shaft to the long tail rotor drive shaft and is easily removable to facilitate maintenance on the main drive system components. The long tail rotor drive shaft is a single piece steel tube supported by a series of grease lubricated hangar bearings and covered by a drive shaft cover.

7-40. Upper Pulley The upper pulley is a grooved aluminum pulley keyed to the main rotor transmission drive pinion and designed with internal spokes that are made in the form of fan blades. The upper pulley has three functions: first to provide rotational speed reduction from the engine power output shaft speed of 6136 RPM at 102% N2 to tail rotor drive shaft speed of 2583 RPM by means of pulley diameter ratio relative to the lower pulley; second to transmit the engine power, delivered by the main drive belt, to the main and tail rotor, and third to provide a motive force to



1. Main Rotor Driveshaft
2. Main Rotor Transmission
3. Main Rotor Transmission Oil Filler Port
4. Upper Drive Pulley
5. Main Rotor Transmission Drive Pinion
6. Tail Rotor Drive Shaft Coupling
7. "H" Strut
8. Engine Power and Accessory Gearbox
9. High Speed Sprag Clutch (Outer Drive Housing)
10. Engine Power Output Shaft
11. Inner High Speed Drive Shaft
12. Flex Coupling Between High Speed Driveshaft and Lower Pulley Driveshaft
13. Lower Pulley
14. Lower Pulley Driveshaft Flex Coupling to Lower Pulley
15. Combustor
16. Combustor Overboard Drain Valve
17. Engine Exhaust Port
18. Engine Inlet Anti-Ice Valve and Control Lever
19. Engine Compressor Section
20. N2 Governor Beep Trim Control Lever

Figure 7-5. Drive System Assembly

draw cooling air over the main transmission and out of the upper engine compartment. The upper pulley is supported at the top of the "H" strut by one grease lubricated bearing located at the aft end of the pulley and the main rotor pinion shaft. Drive belt tension is maintained by the "H" strut.

7-41. Lower Drive Pulley The lower drive pulley is a small diameter grooved aluminum pulley designed to receive the power from the engine by means of the drive shafting out of the overrunning clutch. The lower pulley rotates at engine power output shaft rotational speed of 6196 RPM at 103% N2. The lower pulley has a dual function; first to provide rotational speed reduction by means of pulley diameter ratio relative to the upper pulley, and second to transmit the engine power to the upper pulley by means of the main drive belt. The lower pulley is held in position at the bottom of the "H" strut by two bearings, one at either end of the pulley. The lower pulley bearings are either grease or oil lubricated. The bearing housings transmit the drive belt tension loads to the "H" strut so that the engine and lower pulley drive shafting only carry torque loads. The lower end of the "H" strut is free floating, i.e. not attached to the airframe, and is held in position by two fixed link rods extending horizontally from each of the lower pulley bearing housings to a vibration absorber on the right side of the aft pylon. These rods are used only for lateral positioning of the lower end of the "H" strut.

7-42. Drive Bearing Hot Caution Light Because the lower pulley rotates at engine power output shaft speed (over 6000 RPM), the condition and proper lubrication of the lower pulley bearings is critical for safe operation. Extensive flight test data has demonstrated that if the bearings are over or under greased they will tend to run hotter than normal, usually not over 140°C, and will self adjust back to their normal operating temperature of 80 to 90°C. If, however, the bearings are in an abnormal operating condition due to impending failure or total loss of lubrication then they will run excessively hot which will damage the bearing seals, destroy the lubricating properties of the grease, and eventually cause bearing failure. For these reasons thermocouples have been installed in the lower pulley housings and the electrical signals from each thermocouple monitored by a bearing temperature monitor. The threshold of the monitor circuit has been set at 120°C, at which point a switch in the monitor circuit will close and activate the DRIVE BRG HOT caution light on the segmented caution panel. Should the bearing temperature subsequently reduce, the switch in the monitor unit will open again at 100°C, with the temperature decreasing, and will extinguish the caution light.

CAUTION

Any activation of this caution light should be taken very seriously, the flight terminated immediately with power applied for the descent and landing, NOT in autorotation, and immediate corrective maintenance performed.

7-43. Lower Pulley Drive System Figure 7-5 depicts the entire drive system assembly. Engine power is transmitted to the drive system through the engine splined power output drive shaft to the high speed overrunning clutch located on the cabin side of the accessory gear case of the engine. The overrunning clutch then transmits the engine torque through a splined shaft that runs back through the center of the engine power output shaft to the rear of the engine accessory gear case where it is coupled to the lower pulley drive shaft by means of a flex coupling. The lower pulley splined drive shaft then passes through the hollow center of the lower pulley and mates with a splined coupling bolted to the aft end of the lower pulley. The splining on the drive shafting isolates the engine from any fore and aft loading in the drive system and the flex coupling between the engine high speed drive shaft and the lower pulley drive shaft allows for as much as 1.5 degrees of pulley-engine angular misalignment.

7-44. Overrunning Clutch The overrunning clutch is installed on the cabin side (front side) of the engine accessory gearbox. The engine power output drive shaft is a splined shaft inside the accessory gearbox. The outer housing of the overrunning clutch forms the driving portion of the clutch and is driven by a hollow splined shaft extension of that housing that slides into the engine power output shaft from the front side of the engine gearbox. In the driving direction the sprags engage and connect the outer housing to an inner drive housing which transmits the engine torque to a splined shaft that passes through the center of the engine power output shaft to the rear of the engine accessory gearbox where it is coupled to the lower pulley drive shaft as described in paragraph 7-43. In the overrunning direction the inner drive shafting, being driven by the rotor system, will be rotating faster than the outer housing of the overrunning clutch and the sprags will disengage thus disconnecting the engine from the rotor drive system. The overrunning clutch is a sealed unit and contains its own lubrication separate from the engine.

Some aircraft are equipped with a vented clutch oil reservoir. The oil reservoir consists of a vented container with a sight glass and service port, and a top air/oil vent line and a bottom oil return line, each running to the bearing housing that supports the clutch. The reservoir is vented at the top, allowing oil to remain in the system while air is forced out and drawn in during engine operation.

7-45. Main Drive Belt

The main drive belt is a one-piece synthetic rubber Poly-V belt with a series of parallel V-ribs molded lengthwise around the inside circumference and Kevlar tension cords that make it extremely strong and fail safe. The belt is made of a high strength shock resistant cord, which provides dimensional stability and long flex life. This cord runs in a continuous fashion around the circumference of the belt and is imbedded in a fiber reinforced rubber compound for maximum cord support and adhesion. The belt is installed under constant static tension and is capable of accepting well over 350 SHP without slipping. The belt is installed over the upper and lower pulleys then tensioned by means of two jack screw adjustment mechanisms within the center of the H-strut. Belt tension is measured and adjusted by means of a belt tensiometer.

7-46. Indicators and Caution Lights

a. Main Transmission Oil Temperature Indicator. The **TRANS OIL** temperature indicator is located in the right side of the instrument panel, Figure 7-3. The indicator displays the temperature of the transmission oil in degrees Celsius. The electrical circuit receives its power from the aircraft 28-volt electrical system through the **XMSN** circuit breaker. This is a wet bulb system dependent on fluid for valid indication.

b. Main Transmission Oil Hot Caution Light. The **MAIN XMSN HOT** caution light on the segmented caution panel will illuminate when the main transmission oil reaches a temperature of 107°C and rising, and will extinguish when the oil temperature reaches 100°C decreasing. The circuit receives its signal from a set of contact closures within the main transmission oil temperature indicator and its electrical power from the aircraft 28-volt electrical system through the **CAUT PNL** circuit breaker.

c. Drive Bearing Hot Caution Light. This caution light is discussed in paragraph 7-42.

d. Main and Tail Rotor Transmission Chip Detector Caution Lights.

(1) General. Both the main and tail rotor transmissions have magnetic chip detectors installed. Whenever sufficient metal particles collect on the plugs to close the electrical circuit the associated chip caution light will illuminate. Each caution light receives its signal from its associated chip detector and power from the aircraft 28-volt electrical system through the **CAUT PNL** circuit breaker.

(2) Programmable Continuity Sensors. Also incorporated in each chip detector circuit is a Programmable Continuity Sensor (PCS). Any time electrical power is applied to the segmented caution panel, or the caution panel test switch is placed in the test position for more than three seconds, the PCS will go through a 5 second continuity check to ensure that both circuits are complete. During that time the **MAIN XMSN CHIP** and

TAIL CHIP caution lights will remain illuminated then extinguish. If there is a break in continuity anywhere in the circuit, the associated caution light in the faulty circuit will not respond to the 5 second test.

e. Main Transmission Pump Caution Light. The **MRGB PRESS** caution light illuminates when the pump inlet pressure is less 4.4-5.9 psi/30.2-40.7 kPa of vacuum. Illumination of the light could be caused by a pump failure, a switch failure, or a broken oil line.

NOTE

The MRGB PRESS caution light will only be installed in aircraft equipped with the main rotor transmission filtration/ cooling system.

SECTION VII. MAIN AND TAIL ROTOR GROUPS

7-47. Main Rotor System The main rotor assembly is a three bladed, high inertia, fully articulated rotor system. The main rotor hub and control system is depicted in Figure 7-6.

a. Rotor Blades. Each blade is of hollow construction consisting of an extruded leading edge spar, with a 7.25 degree twist, and to which is bonded upper and lower aluminum skins. The root retention is composed of a bonded doubler assembly and a single retention pin connecting the blade root to the blade grip and a non-adjustable drag brace connecting the trailing edge of the blade to the grip. A cap is bonded to the tip of each blade in which there are provisions for spanwise and cordwise balance weights. Two tracking tabs are riveted to the trailing edge of each blade.

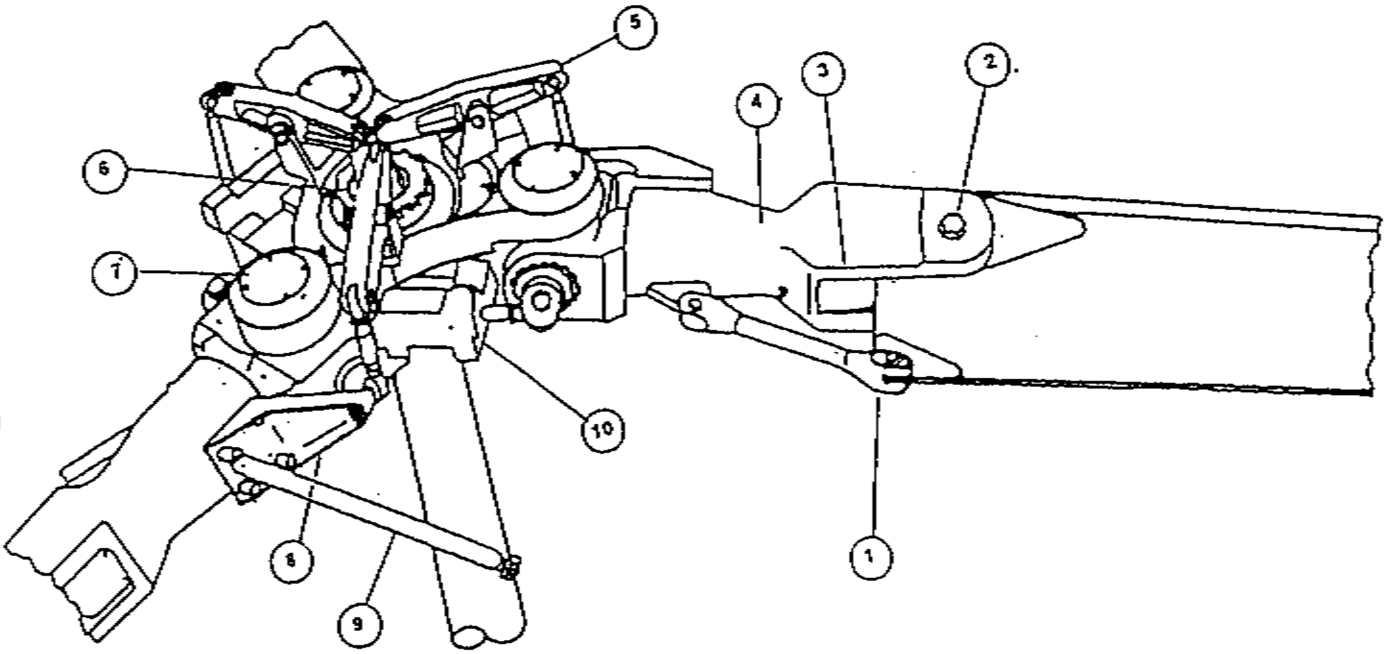
b. Rotor Hub. The rotor head assembly is composed of two opposing forged aluminum hub plates separated by an aluminum cylindrical spacer. Through bolts hold these items together along with steel spline adapters. Three steel universal blocks are mounted in roller bearing units that permit flapping and lead-lag motions. Laminated phenolic pads are used to limit blade travel in both the lead-lag and flapping axes. A thrust nut on the bottom of each universal block transfers vertical blade forces to both hub plates through the universal block. The rotor blades are secured to each universal block on the hub through a forged aluminum grip which is in turn secured to a steel spindle assembly through a retention nut and supporting bearings. Centrifugal blade loads are carried by a fail-safe Lamiflex elastomeric bearing assembly mounted between the blade grip and the spindle. Blade feathering loads into the collective flight control system are balanced throughout the flight regime by Planipetal weights that are a part of the pitch change horn on the leading edge of each blade grip. The Lamiflex bearing and Planipetal weight installation is only installed on 480's Serial Numbers 5001 - 5006 and even those aircraft may have been modified with the tension-torsion strap assemblies. Starting with 480 Serial Number 5007, the lamiflex bearing and planipetal weight assemblies are replaced by tension-torsion strap assemblies. Starting with 480 Serial Number 5042, the flapping bearings in the universal blocks are oil lubricated verses grease lubricated. Oil reservoirs for the flapping bearings are mounted on the top of the main rotor hub. Either closed circuit hydraulic dampers or elastomeric dampers are incorporated between each flapping pin and the rotor hub to limit the lead-lag velocity of the blades.

7-48. Main Rotor RPM Indicator The rotor tachometer indicator is part of the dual tachometer and is located on the instrument panel above the engine instrument cluster. The tachometer inner scale displays the rotor RPM. The inner scale pointer is marked with an "R".

The main rotor tachometer indicator is a digital system, powered by the aircraft 28-volt electrical system through the NR circuit breaker, and driven by a magnetic pickup mounted in the main rotor transmission. The pickup generates pulses that are a function of main rotor ring gear tooth passage. These pulses are then used to drive a stepper motor within the indicator which in turn positions the main rotor RPM pointer marked "R" to indicate the RPM of the main rotor on the inner scale of the dual tachometer indicator. Because this is a digital system, the RPM of the main rotor is retained as a digital pulse when it is displayed to the pilot. The system has a 0.5% resolution and system accuracy. Therefore as the needle moves, it will appear to step from one value to the next rather than present a smooth movement as would normally be expected from the usual analog type display. The advantage of this system over the traditional analog display is its accuracy and reliability over the life of the instrument. The instrument goes through a self calibration cycle every time power is applied thus assuring that the calibrated system accuracy is stable for the life of the instrument. In the event of a main electrical bus failure, this instrument can be driven directly from the aircraft battery by moving the "N2/NR" switch (located near the tachometer) from "MAIN BUS" to "BATT BUS".

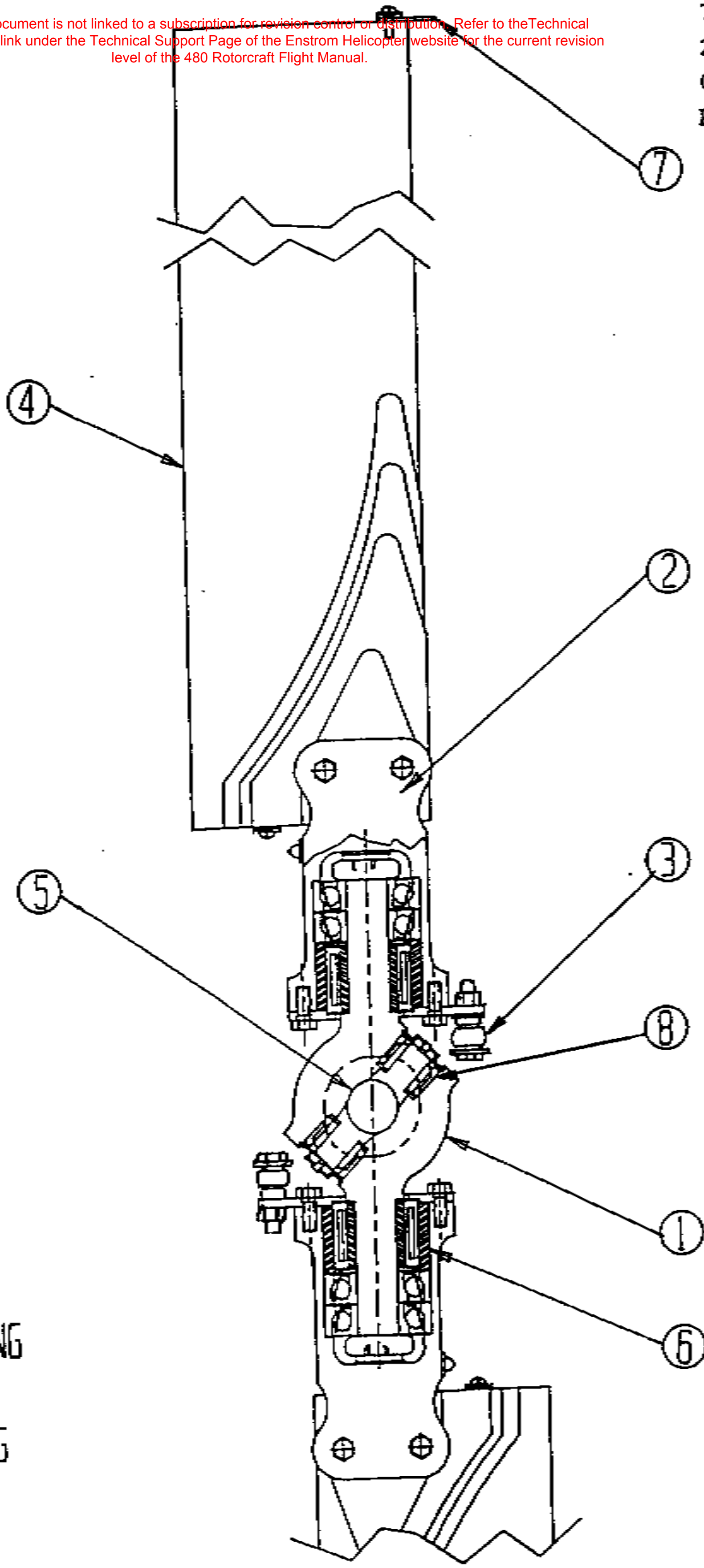
7-49. Low Rotor RPM Warning System A low rotor warning system is installed to provide a visual and audio indication of low rotor RPM. The low rotor RPM circuit is comprised of a magnetic sensor in the main rotor transmission, a signal conditioning unit located behind the instrument panel, a red warning light at the top of the instrument panel, and a warning tone generator and horn. The magnetic sensor is located in the forward portion of the main rotor transmission housing. It is positioned to sense the passage of the ring gear teeth. The signal is sent to a small unit located in back of the instrument panel. The unit receives the signal from the sensor and activates the light and the horn at 334 +/-1 rotor RPM. The light activates regardless of collective position. The audio system, however, is controlled by a microswitch located at the base of the pilot's collective. With a low rotor RPM condition, the audio signal will be silent as long as the collective is down and the microswitch is closed. With the collective off of the down stop the low rotor RPM horn will activate generating a pulsing tone of 2900 Hz at 80-95 decibels. The system threshold can be adjusted using the potentiometer on the top of the signal conditioning unit. Power for the low rotor RPM warning system is provided by the aircraft 28-volt electrical system through the **LOW ROTOR** circuit breaker. There is no high rotor RPM warning.

7-50. Tail Rotor System The tail rotor assembly is a two bladed, teetering, delta hinged rotor system and is depicted in Figure 7-7. The tail rotor head is composed of a spindle and two blade grip fittings mounted on a common spindle by the use of matched DT or angular contact ball bearings and one needle bearing per grip. This rotating assembly is teeter mounted on a center hub by the use of either two spherical bearings or two needle bearings. The center hub is splined to match the tail rotor gearbox output shaft for positive mounting and driving. The control of this assembly is accomplished through cables up to a sliding pivot yoke, thence through pitch change links to the blade grips. Blade pitch is controlled by links actuating both blades simultaneously.



1.	Fixed Drag Link Bolt	6.	Main Rotor Retention Nut
2.	Blade Retention Bolt	7.	Universal Block
3.	Lamiflex Bearing Housing	8.	Pitch Change Horn
4.	Blade Grip Assembly	9.	Planipetal Weight
5.	Pitch Change Walking Beam	10.	Main Rotor Lead Lag Damper

Figure 7-6. Main Rotor System



1. SPINDLE
2. GRIP
3. PITCH LINK
4. BLADE
5. HUB
6. FEATHERING BEARING
7. STRIKE TAB
8. TEETERING BEARING

Figure 7-7. Tail Rotor

SECTION VIII. HEATING AND VENTILATION

7-52. Optional Bleed Air Heating and Defogging System. Cabin heating and defogging can be provided by an optional bleed air type system which consists of bleed air plumbing, two bleed air valves, two heater ejectors, two defogging flow diverters, and associated distribution system. (Only a fan defogger is provided if this system is not installed). The heater control valve is located under the cabin floor and the heater control, labeled **HEAT**, is used to operate the valve which modulates the bleed air flow to control the amount of heat supplied to the cabin. The heater control is located on the aft side of the center pedestal (Figure 7-3.2). The defog control valve is also located under the cabin floor and its control, labeled **DEFR**, is located on the aft side of the center pedestal (Figure 7-3.2). When turned on, the heater ejectors use hot compressor bleed air to pull cabin air into a small mixing chamber and then expel the warm air into the cabin through eyeball socket type nozzles on both sides of the center pedestal near the pilot's and copilot's feet. The nozzles can be swivelled to direct warm air as the crew desires. The defog system diverts some of the bleed air used for the heater system and routes it to a set of two ejectors and distributors mounted forward of the instrument console at the base of each front windscreen. The control can be used to modulate the amount of bleed air routed to the defogging ejectors to control windscreen defogging. There is a small effect on aircraft performance which is addressed in the performance section.

NOTE

The control for the defogger might also be labeled "DEF" or "DEFROST".

7-53. Ventilation System

a. Normal Flow Through Ventilation. The aircraft is equipped with sliding window vents in each cockpit door to direct ram air into the cabin. There is also a pop out type vent on each side of the cabin in the lower portion of each rear opera window to provide additional flow across the back of the cabin area. Additionally, the doors can be removed for flight if desired.

b. RAM Air Ventilation System. In addition to the normal flow through ventilation, the aircraft can also equipped with an optional RAM air ventilation system. The control for this system, labeled **VENT**, is located on the aft side of the center pedestal (Figure 7-3.2). When activated, RAM air from outside the cockpit flows through a distribution system with nozzles mounted either side of the instrument panel.

SECTION IX. ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEM

7-54. General

The 480 helicopter is equipped with a 28-volt direct current electrical system. A simplified electrical system diagram is shown in Figure 7-8 and is supplied by a 28-volt, direct current, 150 ampere, engine driven starter-generator, in conjunction with a 24-volt, NiCad battery or an optional lead acid battery, and an external power receptacle. Control of the electrical system is provided by the switches in the electrical switch section of the instrument panel and the circuit breakers on the lower radio console. All circuits of the electrical system are protected by push-to-reset or switch type circuit breakers. All circuits in the electrical system are single wire with common ground return. The negative terminals of the starter-generator and the battery are grounded to the helicopter structure.

7-55. Battery

A single lead acid battery is used on the aircraft. An optional NiCad battery may be used in lieu of the lead acid battery. All batteries have identical 2 pin MS-3509 electrical receptacle connectors. The battery is normally located on a platform aft of the right cabin backwall and is protected by a current limiter located in the same area. The current limiter may only be replaced by authorized maintenance personnel. Additionally, for all NiCad installations, a battery temperature monitoring and warning system has been installed. At or above 145°F (63°C) the system will trigger the yellow "battery temp" caution light on the cockpit caution panel to alert the pilot to the requirement for corrective action to prevent a thermal runaway. When the battery reaches 160°F (71°C), the monitor system will illuminate the red "battery hot" warning light in the center of the caution panel to warn the pilot that a thermal runaway is imminent if positive corrective action by removing the battery from the charging circuit is not accomplished immediately.

NOTE

On Enstrom 480 models equipped with a (3) place back seat, wiring and tie down provisions are provided to relocate the battery to the baggage compartment to help maintain longitudinal C.G.

7-56. External Power

Receptacle During ground operations external power may be connected to the electrical system through an external power receptacle located on the right side of the aircraft (near the battery) beneath the engine access panel. The external power receptacle consists of a female connector that has two large pins and one small pin. The small pin closes the external power relay and connects the ground unit to the main aircraft electrical bus when external power is supplied. The **GEN** switch should be in the **OFF** position when external power is connected. The battery, however, will be charged anytime that external power is supplied to the aircraft, regardless of the battery switch position. See paragraph 8-9, Servicing, in Chapter 8 of this chapter, for the proper rating for an external power cart and the proper procedures for applying external power.

7-57. Generator

The 150 ampere capacity starter-generator is mounted on the engine power and accessory gearbox and supplies 28-volt direct-current power for operation of the aircraft electrical equipment and for battery charging. The maximum allowed output is 110 amperes.

a. Generator. Generator operation is controlled by the **GEN - OFF** switch. At flight idle RPM and above the voltage regulator portion of the generator control unit (GCU) automatically maintains the correct generator output by varying the generator field current. The generator field circuit is protected by the **MAIN GEN** circuit breaker located on the radio console circuit breaker panel. Additionally, the aircraft

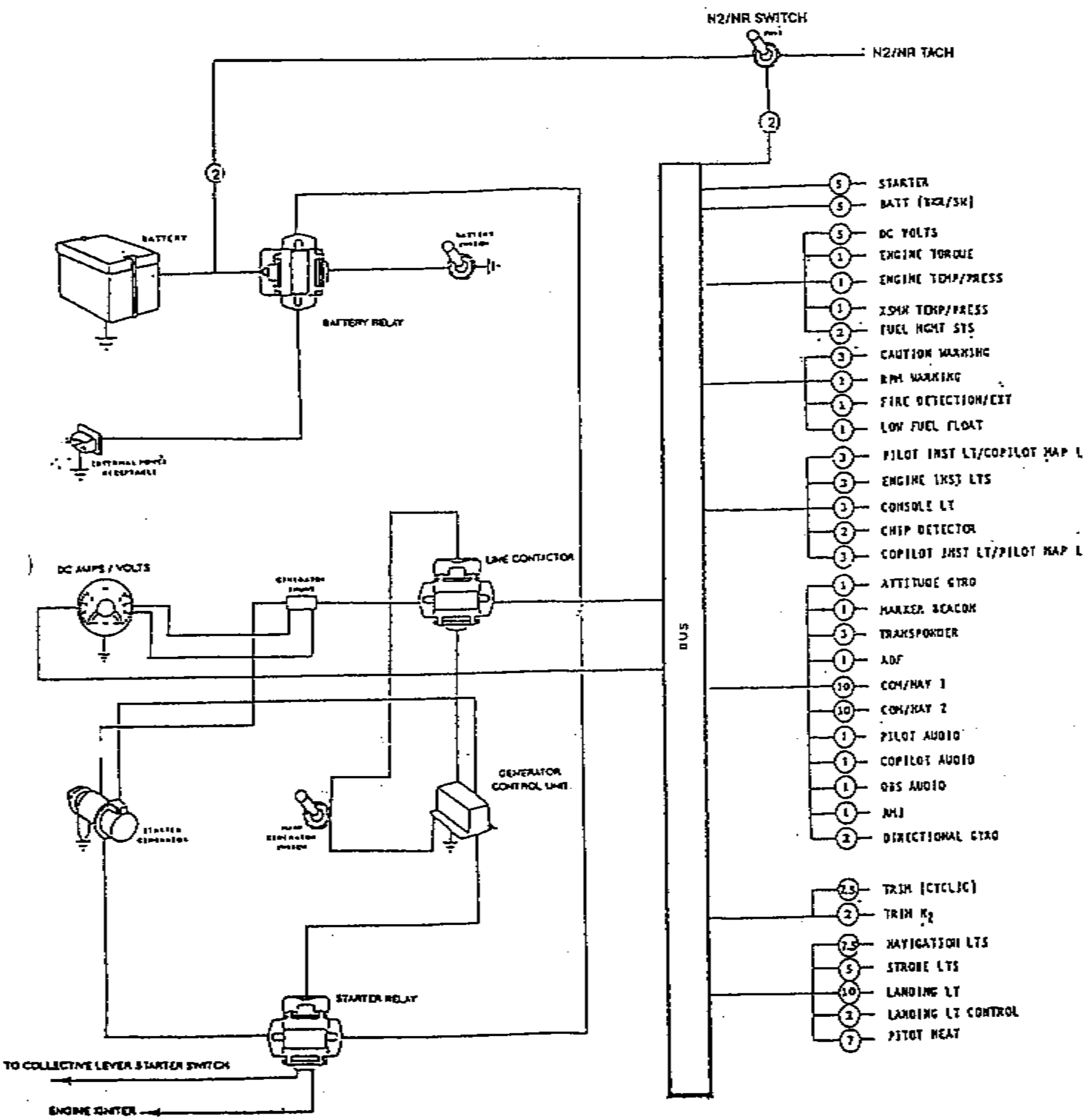


Figure 7-8. Simplified Power Distribution Diagram

electrical system is protected from a generator feeder fault by a current limiter.

b. Generator Control Unit. The generator control unit (GCU) provides control and protection for the generator and outputs for cockpit displays. The seven main functions are:

1. Voltage regulation

2. Overvoltage protection

4. Over current protection

5. Voltage/load indicator display drive

6. Generator failure indication for the caution panel

7. Generator field excitation

When an overvoltage condition occurs, an overvoltage relay is energized by the GCU. The overvoltage relay opens the switch circuit of the reverse current relay to remove generator output from the bus. The reverse current relay prevents the battery from discharging through the generator when the output voltage falls below battery voltage. The aircraft electrical systems operate from the battery when the generator is OFF or off line and the battery switch is ON.

7-58. Generator Caution Light

Anytime that the DC generator output voltage is less than the battery voltage or the generator is OFF or otherwise disconnected from the aircraft main bus, the generator caution light, marked **DC GEN** on the segmented caution panel, will illuminate.

7-59. Controls and Indicators

a. Volt-Ammeter. The dual indicating volt-ammeter is mounted in the instrument cluster on the instrument panel and indicates the main bus voltage and the ampere load being used. The indicator is powered by the aircraft 28-volt electrical system through the **VOLT/AMP** circuit breaker located on the radio console.

b. Battery Switch. The **BATT** switch is located on the instrument panel in the center switch cluster. Battery electrical power is supplied to the helicopter's electrical system when the switch is in the **UP** position. When the switch is in the **UP** position, it closes the circuit to the actuating coil of the battery relay and battery power is then delivered from the battery to the main electrical bus. When the switch is placed in the **DOWN** position, it opens the circuit to the actuating coil of the battery relay and no power is delivered from the battery to the essential bus.

c. Generator Switch. The generator switch, labeled **MAIN GEN**, is located in the instrument panel switch cluster to the left of the battery switch. In the up position the generator field is energized through the generator control unit and 28-volt generator power is supplied to the main electrical system bus. In the **DOWN** position, the generator is electrically removed from the electrical system.

NOTE

The generator switch will be automatically tripped off if the engine starter button is pushed. It must be placed "ON" after the engine start is complete.

d. Circuit breakers. The main circuit breaker panel for the aircraft is located on the radio console. Each individual circuit breaker is clearly labeled for the particular electrical circuit protected. In the event a circuit becomes overloaded, the circuit breaker protecting the circuit will pop out. The circuit may be reactivated by pushing the circuit breaker button back in thereby resetting the circuit breaker. Circuits for devices using direct power feed from the battery are protected by breakers located in the battery compartment.

e. Fuses. Nonessential equipment circuits are fuse protected. The fuses are located on the left side of the center pedestal.

SECTION X. LIGHTING

7-60. Position Lights The position lights consist of four lights and are a part of the nav light/ anticollision light clusters located on each tip of the horizontal stabilizer (right side green, left side red, and a white light facing aft in each cluster). Power for the nav lights is provided by the aircraft 28-volt electrical system through the **NAV LTS** circuit breaker switch.

7-61. Anticollision Lights High intensity flashing strobe-type anticollision lights are located on the tips of each horizontal stabilizer. Power and control for the operation of the strobe lights is provided by the aircraft 28-volt electrical system through the **STROBE LTS** circuit breaker switch.

7-62. Landing Light A moveable landing light is located in the lower nose section of the helicopter. Power for both the landing light and the control motor to extend and retract the landing light is provided by the aircraft 28-volt electrical system. The landing light may be activated by the switch on the pilot's collective control electrical switchbox labeled **LDG LT**. The landing light power switch controls a relay that provides the current to the light. Therefore, the circuit from the collective switchbox to the relay is protected by the **LDG LT RLY** circuit breaker, while the actual light circuit is protected by the **LDG LT** circuit breaker. Positioning of the landing light vertically may be accomplished by the use of the serrated top, three position switch labeled **LDG LT CTRL** on either the pilot's or copilot's collective switchbox. The landing light control switch is a momentary switch spring loaded to the center-off position. When the switch is pressed forward to the **EXTD** position the landing light extends, (the light beam moves upward), as long as the switch is held in this position. When the switch is pulled down toward the pilot, the landing light retracts, (the light beam moves downward), as long as the switch is held in this position. The landing light may be positioned anywhere within a 45 degree arc of travel in this manner. Releasing the switch to the center-off position removes power from the motor and stops the movement of the light. A priority relay is installed to ensure that in the case both pilots activate the switch, the first one to activate the motor has control of the landing light. The landing light positioning motor is protected by the **LDG LT ACTR** circuit breaker.

7-63. Instrument Lights The instrument lights are separated into three groupings; panel instruments, engine instruments, and radio instrument and are so labeled. Each grouping is controlled by its own associated solid state dimmer. Power to the dimmers are provided by the "panel light" switch. Clockwise rotation of the control from the **OFF** position activates the associated circuit and increases the lighting brilliance. Counterclockwise rotation of the knob dims the selected circuit.

7-64. Cockpit Map Lights One hand held cockpit map/utility light is provided for the crew. The light is stowed for flight in the bayonet type holder and is within easy reach of the crew in flight. The map light has a red filter that may be positioned over the normal white light, and a rheostat at the back of the light unit to control the intensity of the light. The light is also equipped with a small momentary push button type rheostat override switch located on top of the rheostat that will activate the light to full bright as long as the switch is held depressed. Power for the map light is provided from the aircraft 28-volt electrical system. Circuit protection for the map light is provided by a fuse.

SECTION XI. FLIGHT INSTRUMENTS

7-65. Airspeed Indicator The aircraft is equipped with a 0 -150 knot airspeed indicator calibrated in knots and miles per hour. The airspeed indicator indicates the airspeed of the helicopter during forward flight by measuring the difference between impact air pressure from the pitot tube and the static air pressure from the static ports mounted just forward of each main cabin entrance door. The standard pitot tube location is below the nose of the aircraft between the chin windows. The pitot tube can be located on the nose to reduce the possibility of it becoming fouled with snow or other foreign substances in adverse operating situations. A chart correcting the cockpit indicated airspeed to calibrated airspeed is presented in Chapter 4, Performance Data, of this manual.

Note
Airspeed indications at airspeeds below 20 knots are unreliable.

7-66. Optional Pitot Heater The aircraft may be equipped with an optional electrically heated pitot tube to prevent ice from forming in or on the pitot tube. Electric power for the pitot heater is supplied from the 28-volt aircraft electrical system through the 5 amp circuit breaker switch located in the switch section of the instrument panel. The switch is labelled **PITOT HEAT**.

7-67. Altimeter and Encoder The aircraft is equipped with a non-altitude encoding pressure altimeter. The altimeter provides a direct reading of height above mean sea level when properly adjusted for the local altimeter setting. The aircraft can be equipped with an optional blind encoder for use with the transponder. The encoder is a sealed unit that is calibrated to provide the transponder coded pressure altitude information based on a standard altimeter setting of 29.92 inches of mercury. The transponder then transmits that altitude information to the ATC radar when transponder mode C is selected by the pilot.

7-68. Attitude Indicator The aircraft can be equipped with an optional AIM 510-1AL, 28-volt, self contained attitude indicator. This unit was specifically designed for the helicopter vibration environment and is equipped with a fixed pointer, moving card type display and a pilot adjustable aircraft reference symbol. The indicator is capable of 360 degrees in roll and 80 degrees in pitch, either up or down, but only has markings for the first 20 degrees either direction in pitch and 90 degrees either direction in roll.

NOTE
This attitude indicator must be erected manually each time electrical power is applied to the aircraft. To prevent unnecessary stress on the erection mechanism it is recommended that the "Pull For Quick Erect" knob be pulled and held by the pilot prior to applying battery or external power to the aircraft.

7-69. Instantaneous Vertical Velocity Indicators The optional vertical speed indicator displays the rate of helicopter ascent or descent in feet per minute. The indicator is capable of indicating up to 6000 feet per minute vertical velocity either direction and is actuated by the rate of atmospheric pressure change.

7-70. Turn and Slip Indicator The optional turn and slip indicator displays the helicopter slip condition, direction of turn, and rate of turn. The ball displays the slip condition. The pointer displays the direction and rate of turn. The indicator receives power from the 28-volt aircraft electrical system and is protected by the **T&SL** circuit breaker.

7-71. Outside Air Temperature Indicator (OAT) The OAT indicator is located at the top center area of the cabin to the left of the front windscreen center post. The indicator displays the OAT in both Fahrenheit and Celsius.

7-72. Magnetic Compass The magnetic compass is mounted in a bracket attached to the center post of the front windscreen over the center of the instrument panel glareshield extension and in full view of both pilot seats. No deviation in magnetic indications will occur when the landing light or pitot heat are turned on.

7-73. Caution and Warning Systems The caution system consists of a segmented caution panel located in the lower right-hand corner of the instrument panel, and a remote **MASTER CAUTION** annunciator, which is also a push-to-reset switch, located on the instrument panel in front of the pilot. The warning system consists of three individual red warning lights located at the top of the instrument panel. The purpose of the caution and warning system is to provide visual indication, suitable for day and night operation, that a fault condition has occurred.

a. Caution System. The caution panel, depicted in Figure 7-9 and described in Table 7-1 is composed of 15 individual worded segments which, when illuminated, identify specific fault conditions. The worded segments are only visible when illuminated. Each segment has two lamps so that the failure of a single lamp will produce only a dimming effect. When a fault occurs, the associated worded segment on the segmented caution panel illuminates flashing at a 2 Hz rate, and the **MASTER CAUTION** light also illuminates flashing at the same rate. When the pilot acknowledges the fault by pressing in on his push-to-reset **MASTER CAUTION** annunciator/switch, the **MASTER CAUTION** light will extinguish and the fault on the segmented caution panel will reset to a steady ON condition. Each fault condition, as it occurs, is indicated by the same sequence of events as described above. In each case, only the new fault will flash until acknowledged. Only faults annunciated by the segmented caution panel will activate the **MASTER CAUTION** light; low rotor, engine out, and fire warning light activation will not. In addition, because the "Engine De-ice" light indicates a normal system status rather than a fault, it will not activate the Master Caution light.

(1) Caution Panel Test. Pressing the caution/warning panel **Test-Dim** toggle switch to the **Test** position will illuminate all 15 segments of the caution panel and the **MASTER CAUTION** light, plus the **FIRE**, **ROTOR RPM**, and **ENGINE OUT** warning lights for test of all of the light bulbs and the three chip detector circuits. Release of the **Test** switch to the center-OFF position resets the segmented caution panel to its previous state before the **Test** switch was pressed. No fault condition will be altered as a result of the test. Holding this switch in the test position for 3 seconds or longer will activate the chip detector continuity test circuits.

(2) Caution Panel Dimming. For night flight the caution/warning panel **Test-Dim** switch can be set to the **Dim** position to select a preset dim condition for the caution panel. In this condition, each fault as it occurs will trigger its associated caution segment to a full bright and flashing condition along with the **MASTER CAUTION** light. Pressing the **MASTER CAUTION** light will reset the caution panel fault segment to steady and dim. Subsequent faults will be annunciated in the same manner with only the new fault triggered to bright-flashing until it is acknowledged, not the previously acknowledged faults.

b. Warning System. The warning system consists of three independent red warning lights at the top of the instrument panel as shown in Figure 7-9 and described in Table 7-2, and one red BATT HOT warning light located in the center of the caution panel and described in paragraph 7-55. Because of its location in the caution panel, the BATT HOT light operates in exactly the same manner as the caution lights described previously. The remainder of this paragraph applies only to the FIRE, ROTOR RPM, and ENGINE OUT warning lights. When each light is activated it comes on steady and full bright with no dimming capability. The warning lights are for conditions that require immediate pilot action.

(1) Low Rotor RPM Warning. This warning system is described in paragraph 7-49.

(2) Engine Out Warning System. This system is described in paragraph 7-28.

(3) Fire Warning System. This system is described in paragraph 7-13.

CAUTION

The FIRE warning circuit is the only one of the three warning systems that is independent from all other circuits in the aircraft. The ENGINE OUT warning, for instance, uses the logic circuitry in the caution panel to evaluate the N_1 signal as a trigger. It is important to remember that disabling one system by pulling a circuit breaker may inadvertently disable or degrade the capabilities of another system. Always cross check other instruments to confirm the operating state of the aircraft and systems.

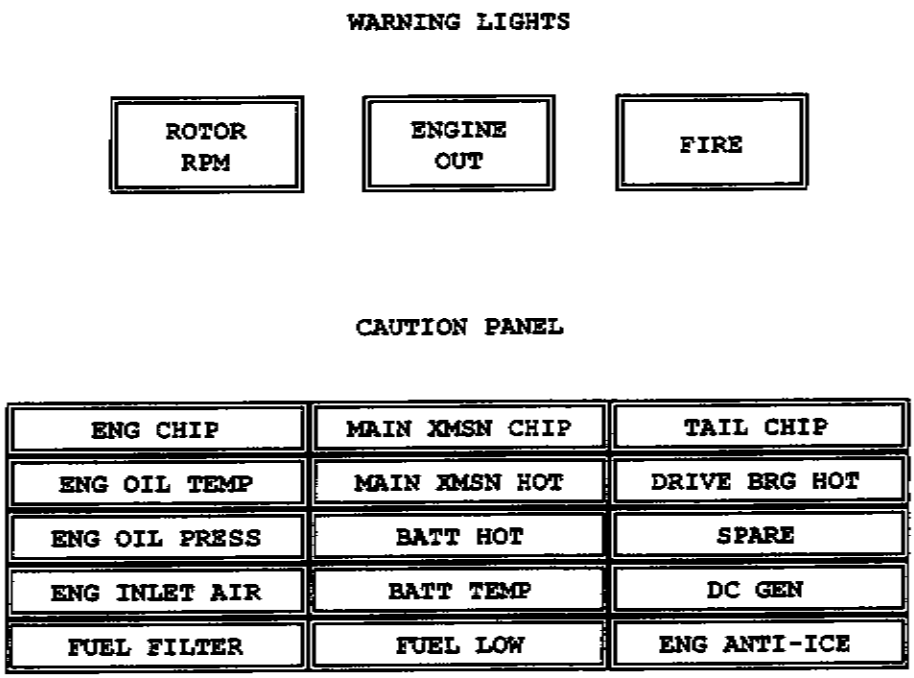


Figure 7-9. Caution and Warning System
(Standard Configuration)

TABLE 7-1. CAUTION PANEL SEGMENTS

SEGMENT	COLOR	DESCRIPTION OF FAULT
ENG CHIP	**AMBER**	Engine scavenge oil has ferrous metal fragments
MAIN XMSN CHIP	**AMBER**	Main transmission chip detector has detected ferrous metal fragments
TAIL CHIP	**AMBER**	Tail rotor gearbox chip detector has detected ferrous metal fragments
ENG OIL TEMP	**AMBER**	Engine oil temperature is above 107°C
MAIN XMSN HOT	**AMBER**	Main transmission oil temperature is above 107°C
DRIVE BRG HOT	**AMBER**	Either the forward or aft lower pulley bearings are above 120°C
ENG OIL PRESS	**AMBER**	Engine N_1 RPM is above 78.5% <u>and</u> engine oil pressure is below 90 psi; (P/N ECD4078 caution panel only: or anytime engine oil pressure is below 50 psi or above 130 psi)
BATT HOT*	**RED**	Battery temperature exceeds 71°C
ENG INLET AIR	**AMBER**	Engine inlet swirl tube particle separator partially blocked
BATT TEMP*	**AMBER**	Battery temperature exceeds 63°C
DC GEN	**AMBER**	DC generator system failure
FUEL FILTER	**AMBER**	Fuel filter bypass is impending
FUEL LOW	**AMBER**	Fewer than 5 gallons/19 liters remaining
ENG ANTI-ICE	**GREEN**	Engine anti-ice is activated
SPARE	**AMBER**	Unused segment
A/F FILTER**	**AMBER**	Airframe fuel filter bypass is impending
MRGB PRESSH	**AMBER**	Pump inlet pressure is less than 4.4-5.9 psi/30.2-40.7 kPa of vacuum

NOTE: On early production aircraft, the engine anti-ice segment was labeled "ENG DEICE". All of the associated references in this RFM and on aircraft placards refer to engine anti-ice. They are one and the same.

* These segments are labeled "SPARE" and are unused if the aircraft is equipped with the optional lead-acid battery.

** The AA/F FILTER@ segment is part of the optional external (airframe mounted) fuel filter kit and will be installed in the ASPARE@ location.

H The AMRGB PRESS@ segment is part of the main rotor transmission filtration/cooling system and will be installed in the ABATT HOT@ location. If the aircraft is equipped with the main rotor transmission filtration/cooling system, the aircraft will be equipped with the optional lead acid battery.

TABLE 7-2 WARNING LIGHTS

LIGHTS	COLOR	DESCRIPTION OF FAULT
ROTOR RPM	RED	Main rotor RPM below 334 RPM
ENGINE OUT	RED	Engine N1 below 58%
FIRE	RED	The fire detection system has detected either a fire or an extreme overheat condition in either the upper or lower engine compartment.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 8

HANDLING, SERVICING, AND MAINTENANCE

SECTION I. GENERAL

8-1. Location of Servicing Points Servicing points are shown in Figure 8-1.

8-2. Servicing Table Refer to Table 8-1 for fuel, lubricants, specifications and capacities. Refer to Table 8-2 for approved commercial oils and fluids.

NOTE

Refer to the TH-28/480 Maintenance Manual, Section 4, for detailed service and lubrication requirements.

SECTION II. FUEL

8-3. Fuel Types

The primary, emergency and cold weather fuels which can be used in the 480 helicopter are presented in Table 8-3. The following definitions apply to the approved fuels table.

a. Primary Fuels. These are the designated primary fuels adopted for worldwide use.

b. Emergency Fuels. These are fuels which can be used if primary fuels are not available. Their use is usually subject to a specific time limit.

c. Cold Weather Fuels. These fuels may be required to assure consistent starts at ambient temperatures below 4°C (40°F). There is no restriction from operating the aircraft on any primary fuels at ambient temperatures down to -32°C (-25°F), however, special provisions may be required to start the engine. (Refer to the Allison 250-C20 series operation and maintenance manual for further information.)

8-4. Use of Fuels

NOTE

At ambient temperatures below 4°C (40°F), all fuels used shall contain Anti-Icing Additive conforming to MIL-DTL-85470. The Anti-Icing Additive shall be added to all commercial fuel, not already containing an anti-icing additive, during refueling operations. Refueling operations shall be accomplished in accordance with accepted commercial procedures. Commercial product PRIST® HI-FLASH™ conforms to MIL-DTL-85470.

a. There is no special limitation on the use of primary fuel, but certain limitations are imposed when emergency fuels are used. For the purpose of recording, fuel mixtures shall be identified as to the major component of the mixture, except when the mixture contains leaded gasoline. A fuel mixture which contains over 10 percent leaded gasoline shall be recorded as all leaded gasoline. The use of any fuels other than standard will be recorded in the Aircraft.

b. The use of kerosene fuels, (JP-5 type), in turbine engines dictates the need for observance of special precautions. Both ground starts and air starts at low temperature (below 5°C) may be more difficult due to low vapor pressure. Kerosene fuels having a freezing point of -40°C or -53°C should be used with caution when the operational temperatures at the intended flight altitude approach those values and either standard fuels sought or the maximum altitudes for the intended operation limited.

c. Mixing of Fuels. When changing from one type of authorized fuel to another, for example JET A to JP-5, it is not necessary to drain the helicopter fuel system before adding the new fuel.

8-5. Fuel System Servicing

The fuel supply system consists of the fuel cells and the crossfeed and supply lines.

a. Precautions in Fuel Servicing and Defueling.

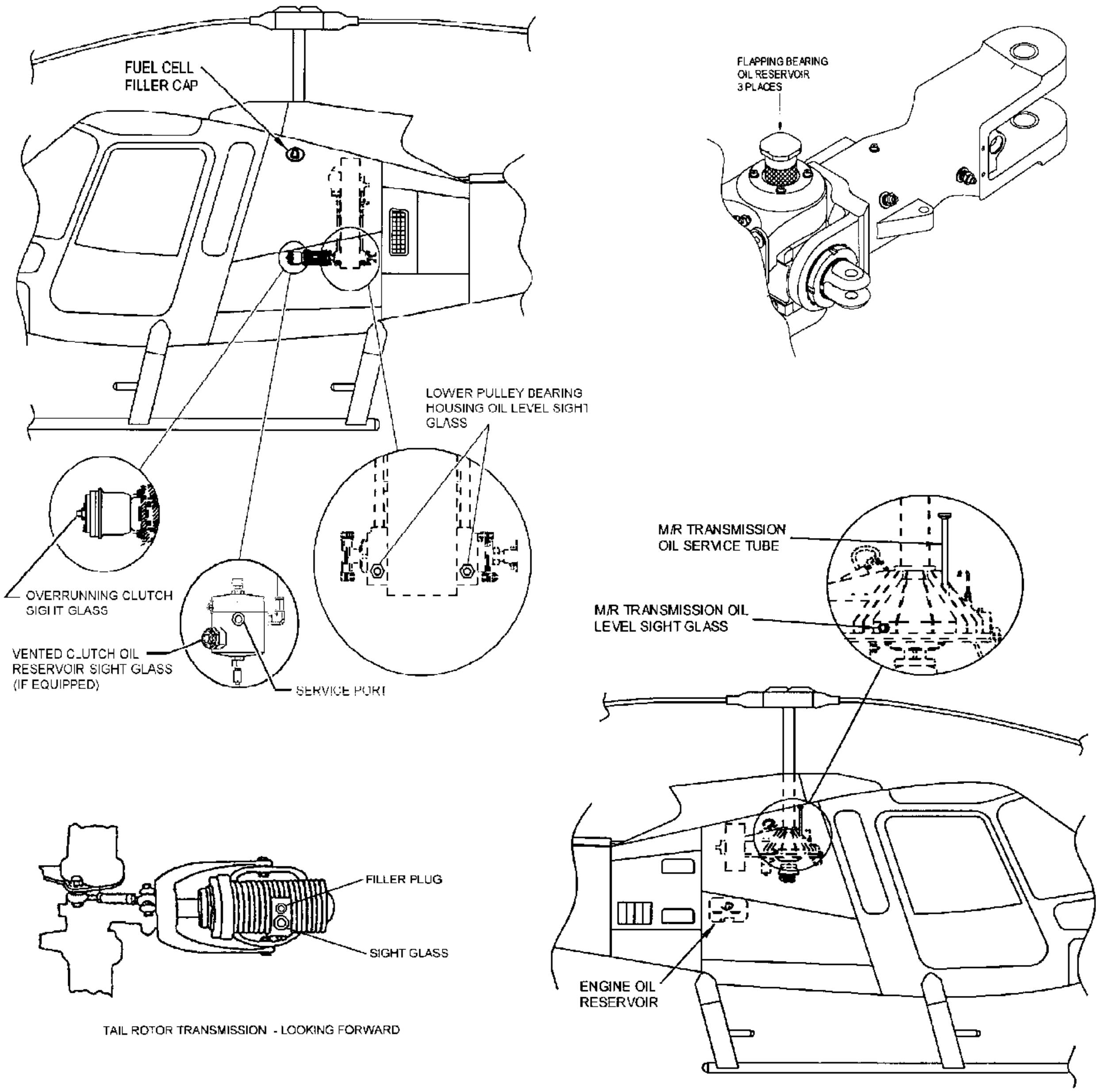


Figure 8-1. Servicing Diagram

CAUTION

Observe the following precautions in all fuel servicing and defueling operations as applicable:

(1) Position auxiliary ground power units on the windward side of the helicopter.

(2) Do NOT fuel or defuel during electrical storms.

(3) Do not fuel or defuel while ground radar sets are operating within 300 feet of the helicopter.

(4) Servicing personnel shall not wear metal taps on their shoes.

(5) Be sure that the battery switch is in the OFF position and external power is disconnected before fueling or defueling the helicopter.

(6) Ground the helicopter at the receptacle located on the top of the left engine access panel to the filler nozzle before removing the filler cap.

(7) The fuel truck shall be grounded (truck to ground and truck to helicopter). The helicopter shall be grounded to the same ground point as is the fuel truck.

(8) After completion of servicing, wash down and remove any spillover of jet fuel. This fuel does not evaporate as rapidly as gasoline and constitutes a fire hazard for a much longer time. Cleaning materials or clothing which have become saturated with jet fuel shall be disposed of properly.

b. Servicing.

(1) Ground the aircraft, truck, and nozzle.

(2) Remove the fuel cap.

(3) Position the nozzle into the fuel cell filler neck.

(4) Fill to the specified level.

(5) Remove the nozzle and replace the fuel cap.

(6) Disconnect the nozzle ground and rewind hose.

(7) Disconnect the truck and helicopter grounds.

CAUTION

Insert nozzle carefully in a generally downward direction, avoiding contact with the inside of the fuel cell. Fuel nozzles must be hand held during servicing.

WARNING

In the event of major spillage of fuel, all powered equipment will be shut down. All personnel will leave the vicinity and be positioned to prevent any sources of possible ignition from entering the area. The fire department will be summoned to the area to contain and disperse the spill safely.

Refer to Table 8-1 for fuel tank capacity.

c. Defueling and Draining.

(1) Ground the aircraft, and defueling truck.

(2) Remove the fuel cap.

(3) Insert a suction pickup from a defueler truck into the fuel filler opening and remove all possible fuel.

NOTE

Defueling may take more time than is expected because the one and one half inch fuel cell crossfeed line is approximately one third of the way up the fuel cell. Once the fuel level falls below that line then the only crossfeed line to move fuel from the right cell into the left cell is the 3/4 inch engine feeder line that connects both cells. A cross check of the right fuel cell quantity using the aircraft fuel gage can be made to see how much remains because the fuel quantity probe is located in the right cell.

(4) To complete defueling, drain remaining fuel into suitable containers by opening the two fuel cell sump drains.

8-6. Engine Oil System Servicing

The engine oil tank is located on the right side of the aircraft under the right engine access panel. Oil level is checked by removing the oil reservoir filler cap and observing the integral metal dip stick attached to the cap. Oil level should be checked within 15 minutes of engine shutdown. Refer to Table 8-1 for the capacity and the authorized oil.

The aircraft can be operated with either MIL-PRF-7808 (formerly MIL-L-7808) or MIL-PRF-23699 (formerly MIL-L-23699) oil. MIL-PRF-23699 is preferred for operation at ambient temperatures above -18°C (0°F). Table 8-2 lists the commercial products available which are approved for use in the engine.

WARNING

Mixing of oils from different series (MIL-PRF-7808 with MIL-PRF-23699) is permitted only in an emergency. The use of such mixed oils is limited to five hours total running time. Refer to the Rolls-Royce 250-C20 series Operation and Maintenance Manual.

CAUTION

Refer to the Rolls-Royce 250-C20 Series Operation and Maintenance Manual for information concerning use and mixing of approved turbine engine oils in the Rolls-Royce 250-C20W.

8-7. Main Rotor Transmission and Tail Rotor Gearbox Oil Servicing

a. Main Rotor Transmission. A sight glass located on the aft right side of the transmission housing can be viewed through the blades of the upper pulley fan by standing on the right side of the aft landing gear crosstube and looking down the tunnel under the upper plenum chamber. The oil level must be visible in the lower one half of the sight glass. If oil is visible then no additional oil is required. If oil is not visible, add oil until the oil is half way up the sight glass. Refer to Table 8-1 for the capacity and the authorized oil. Table 8-2 lists the commercial products available which are approved for use in the main rotor transmission.

b. Tail Rotor Gearbox. A sight glass is provided for ease in checking the oil level. Refer to Table 8-1 for capacity and authorized oil. Fill to where there is just barely a small bubble at the top of the sight glass with the aircraft sitting fairly level. Table 8-2 lists the commercial products available which are approved for use in the tail rotor gearbox.

NOTE

The quantity of oil used to service the transmission after an oil change will completely fill the sight glass. A small bubble will not be visible in the sight glass unless the aircraft is positioned in a tail high attitude.

8-8. Lower Pulley Bearing Housings

NOTE

The following procedure is only applicable if the aircraft is equipped with oil lubricated lower pulley bearings.

A sight glass is provided in the lower pulley bearing housings to determine the oil level in the bearing housings. The sight glasses are located behind the left side engine access panel. The oil level in the bearing housings must be visible in the lower one half of the sight glass. Refer to Table 8-1 for the capacity and the authorized oil. Table 8-2 lists the commercial products available which are approved for use in the lower pulley bearing housings. If oil is visible then no additional oil is required. If oil is not visible, use the following procedure to service the lower pulley bearing housings.

a. Remove the service plug(s) located above the temperature probe on the opposite side of the bearing housing(s).

b. Add oil until the oil is half way up the sight glass.

c. Reinstall the service plug(s).

NOTE

Do not fill the oil level higher than one half of the sight glass. Oil levels higher than one half the sight glass can cause bearing over-temperature indications.

8-9. Overrunning Clutch

NOTE

The following procedures are only applicable if the overrunning clutch cover is equipped with a sight glass or if the aircraft is equipped with the vented clutch oil reservoir.

1. A sight glass is incorporated into the overrunning clutch cover to determine the oil level in the overrunning clutch (Refer to Figure 8-1). Access to the sight glass is through the left side engine access panel.

2. For aircraft equipped with a vented clutch oil reservoir, a sight glass is incorporated into the reservoir container (Refer to Figure 8-2). Access to the reservoir sight glass is through the left side engine access panel. Since the oil reservoir sight glass and the overrunning clutch cover sight glass are at the same height, the oil level should be the same.

3. If oil fills sight glass(es) then no additional oil is required.

4. If the sight glass is not full of oil, and the aircraft is not equipped with a vented clutch oil reservoir, use the following procedure to service the overrunning clutch (Refer to Figure 8-2). Refer to Table 8-2 for the capacity and the authorized oil. Table 8-3 lists the commercial products available which are approved for use in the overrunning clutch.

a. Open the left side engine access panel.

b. Rotate the clutch until one of the cap plugs is at the 12 o'clock position (as seen by looking aft) and remove the plug.

c. Slowly rotate the clutch clockwise until oil drains from the port. Note the position of the oil level. The clutch is properly serviced if the level is between the 12:00 and 3:00 positions.

d. Service the clutch by rotating the port to the 12:00 position and slowly adding oil with a squirt can/syringe until oil flows from the port. Reinstall the plug and lockwire (.025").

e. Wipe up the excess oil.

5. If the clutch cover sight glass and the reservoir sight glass are not full of oil, service the overrunning clutch via the service port on the reservoir container. Slowly add oil to just below the service port (Refer to Figure 8-2). Ensure sufficient time for the oil to flow to the ORC. Refer to Table 8-2 for the capacity and the authorized oil. Table 8-3 lists the

commercial products available which are approved for use in the overrunning clutch.

NOTE

Corrective maintenance action is required if the overrunning clutch requires servicing after less than 10 hours of flying. Refer to the TH-28/480 Series Maintenance Manual for corrective action requirements.

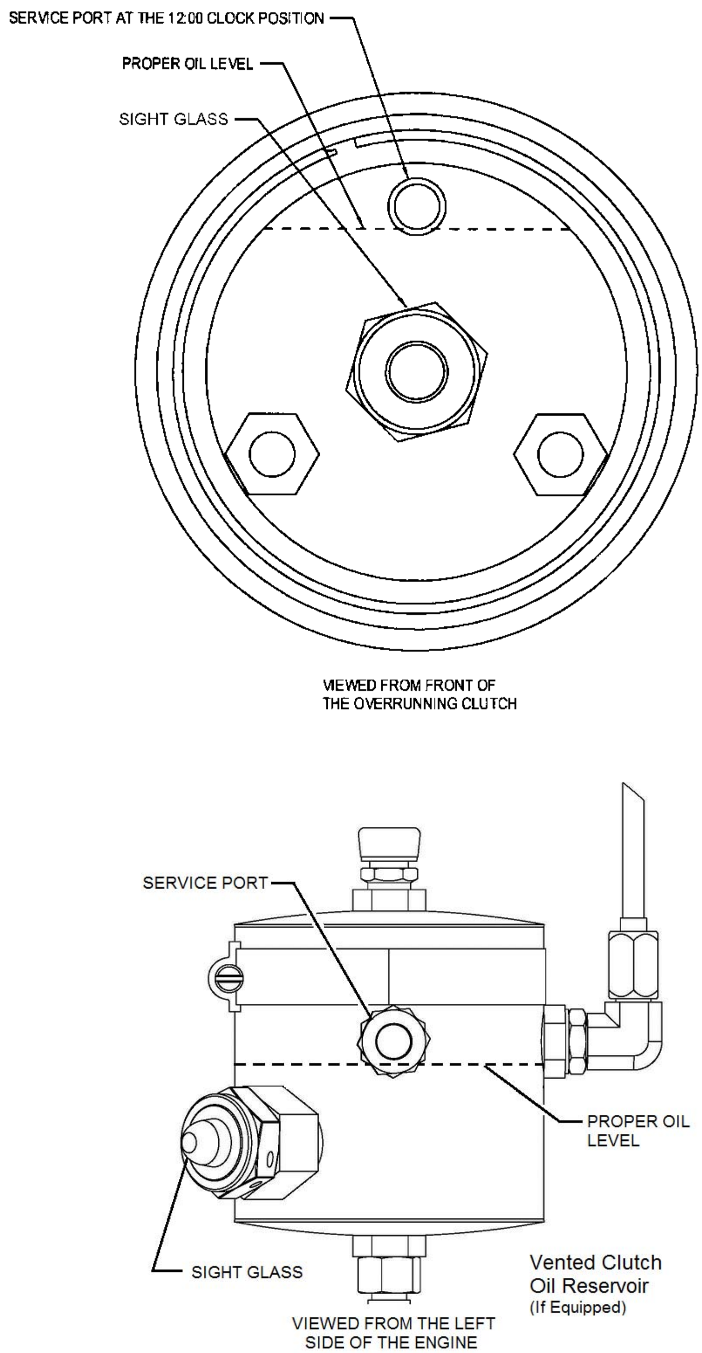


Figure 8-2. Overrunning Clutch Servicing

8-10. Oil Lubricated Flapping Bearings

NOTE

The following procedure is only applicable if the aircraft is equipped with oil lubricated flapping bearings.

The reservoirs for the oil lubricated flapping bearings are located on top of the main rotor hub(Refer to Figure 8-3). The oil level in the reservoirs should be between the top of the dust cover and three quarters (3/4) full. Refer to Table 8-1 for the capacity and the authorized oil. Service the flapping bearing reservoirs using the following procedure.

a. Remove the reservoir cap and replace the O-ring (internal thread reservoir) or seal (external thread reservoir) as required.

b. Fill the reservoir until the reservoir is half (1/2) to three quarters (3/4) full.

c. Install the cap until the O-ring or seal on the cap contacts the reservoir. Tighten the O-ring equipped cap an additional one half (1/2) turn **maximum** by hand. Torque the seal equipped cap 10-20 in-lbs (1.1-2.3 Nm) or tighten an additional one sixteenth (1/16) turn **maximum** by hand.

NOTE

Corrective maintenance action is required if the reservoir(s) is/are empty after four (4) hours of flying.

SECTION VI. LANDING GEAR

8-11. Landing Gear Oleos

Check the landing gear oleos for proper inflation by observing the condition placard installed on the inboard side of the lower oleo fairings (Refer to Figure 8-4). The bottom edge of the upper oleo fairing is used as the indicator for determining the condition of the oleo.

NOTE

The landing gear oleo condition placard should be used as a guide in determining the condition of the oleos. Factors such as optional equipment, loaded baggage, ambient temperature, and the surface the aircraft is parked on can affect the accuracy of the placard indications.

Refer to Table 8-0 for condition/corrective action information related to the condition placard.

Refer to the TH-28/480 Series Maintenance Manual when the landing gear oleos require servicing.

NOTE

To prevent erroneous indications of the aft oleos, lift up on the end of the tail cone to redistribute the weight of the aircraft if the aircraft has been moved using the ground handling wheels.

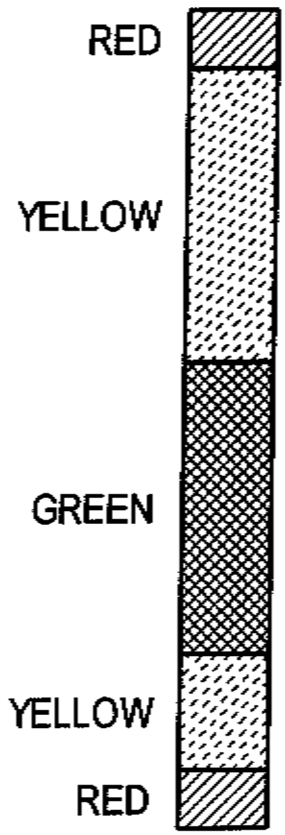


Figure 8-4. Landing Gear Oleo Condition Placard

Table 8-0. Landing Gear Oleo Condition Placard

COLOR	CONDITION/CORRECTIVE ACTION
GREEN	SERVICEABLE - NO CORRECTIVE ACTION
YELLOW	SERVICEABLE - MAY REQUIRE SERVICING IN THE NEAR FUTURE
RED	UNSERVICEABLE - REQUIRES SERVICING

SECTION VII. GROUND OPERATIONS

8-12. Ground Handling

Ground Handling Wheels. A set of dual ground handling wheels is provided for moving the aircraft on the ground. The ground handling wheels attach to the skids at the lugs provided near the aft oleo struts. The wheels are an over center type. The wheels must be removed from the skids prior to flight.

NOTE

Do not ground handle by pushing or pulling on the stabilizer or by pushing on the nose of the cabin.

8-13. External Power

A 28-volt DC unit with a minimum output of 300 amperes is required for starting.

a. Turn the helicopter battery and Generator switches OFF.

b. Turn the external power OFF.

c. Plug the external power source cable securely into the external power receptacle.

d. Turn the external power source ON.

e. Turn the helicopter battery switch ON.

8-14. Parking

a. Retract the ground handling wheels and remove, allowing the helicopter to rest on its skids.

b. Install the main rotor tiedown

c. Install static ground.

d. Install the main rotor hub cover.

e. Install the tail rotor gearbox and hub cover.

8-15. Snow and Ice Removal

a. Remove all ice and snow accumulations from the top of the cabin, the top of the fuselage adjacent to and forward of the inlets, and from both inlet particle separator swirl tube assemblies prior to any flight.

b. The best method of unblocking swirl tubes blocked by snow is to pull the aircraft into a heated hangar, open the rear inspection panel on the upper plenum, and use a heat gun on LOW heat to blow from the inside of the plenum back through the swirl tubes until all snow has melted. Shop air can then be used to gently blow remaining moisture from the inside toward the outside of the swirl tube panel. DRY OFF the rest of the fuselage and blades and observe the following CAUTION for resumed operation:

CAUTION

Install covers over the blades and inlets prior to moving the aircraft from a heated hangar out into any precipitation where the outside air temperature is at or below freezing. Let the aircraft cool for at least 30 minutes before removing all covers for flight. Remove all ice and snow that has built up on the fuselage before removing covers. Minimize any delays in starting the engine and rotor after removing all covers to prevent snow from re-accumulating on the fuselage and flying surfaces.

TABLE 8-1. FUELS, LUBRICANTS, SPECIFICATIONS, AND CAPACITIES

SYSTEM	SPECIFICATION	CAPACITY
Fuel - Standard	ASTM D1655 Jet A or A1 ASTM D6615 Jet B MIL-DTL-5624 JP-4 & JP-5 MIL-DTL-83133, Grade JP-8 (See Notes 1, 2, and 3)	91.7 U.S. Gals (90.0 usable) 347.08 liters (340.65 usable) (See Note 4)
Fuel - Crashworthy	ASTM D1655 Jet A or A1 ASTM D6615 Jet B MIL-DTL-5624 JP-4 & JP-5 MIL-DTL-83133, Grade JP-8 (See Notes 1, 2, and 3)	90 U.S. Gals (89.7 usable) 340.7 liters (339.5 usable) (See Note 4)
Engine Oil	MIL-PRF-7808 MIL-PRF-23699 (See Note 5)	12 U.S. Pints 5.7 liters
Overrunning Clutch	MIL-PRF-23699 (See Table 8-3)	3.8 U.S. Ounces 110 ml
Overrunning Clutch with Vented Clutch Oil Reservoir (if equipped)	MIL-PRF-23699 (See Table 8-3)	6.5 U.S. Ounces 192 ml
Main Rotor Transmission	MIL-PRF-2105/API GL-5 (See Table 8-3)	6 U.S. Pints 2.84 Liters
Tail Rotor Transmission	MIL-PRF-2105/API GL-5 (See Table 8-3)	5 U.S. Ounces 150 ml
Main Rotor Flapping Bearings	MIL-PRF-23699 (See Table 8-3)	As Required
Lower Pulley Bearings	MIL-PRF-23699 (See Table 8-3)	.27 U.S. Ounces 8 ml

NOTES:

1. Refer to Table 8-3 and the Rolls-Royce 250-C20 Series Operation and Maintenance Manual (10W2) for a complete listing of the approved Primary, Emergency, and Cold Weather fuels.

2. MIL-G-5572 fuel containing tricresylphosphate shall not be used.

3. At ambient temperatures below 4°C (40°F), all fuels used shall contain Anti-Icing Additive conforming to MIL-DTL-85470. The Anti-Icing Additive shall be added to all commercial fuel, not already containing an anti-icing additive, during refueling operations. Refueling operations shall be accomplished in accordance with accepted commercial procedures. Commercial product PRIST® HI-FLASH™ conforms to MIL-DTL-85470.

4. The fuel cells for the standard fuel system are designed for a total capacity of 91.7 gallons (347.08 l) and the fuel cells for the crashworthy fuel system are designed for a total capacity of 90 gallons (340.65 l); however, differences in baffle installation in both the standard and crashworthy fuel system will result in a slight variance in total fuel capacity between aircraft.

5. The following is the recommended oil for the specified average daily temperatures:

Outside Temperature	Recommended Oil
0°C (32°F) and above	MIL-PRF-23699 preferred
0°C (32°F) to -40°C (-40°F)	MIL-PRF-23699 preferred or MIL-PRF-7808
-40°C (-40°F) and below	MIL-PRF-7808

TABLE 8-2. APPROVED COMMERCIAL OILS

MIL-PRF-7808

MANUFACTURER	MANUFACTURER'S DESIGNATION
Air BP Lubricants	BP Turbo Oil 2389
American Oil	American PQ Lubricant 689
Castrol Inc.	Brayco 880
Exxon Mobil Oil	Mobil Avrex S Turbo 256, Mobil RM-201A, or Mobil RM-184A
Stauffer Chemical	Stauffer Jet 1

MIL-PRF-23699

MANUFACTURER	MANUFACTURER'S DESIGNATION
Mobil Oil	Mobil Jet Oil II
NYCO America	Turboycoil 600 (TN600)
Anderol Specialty Lubricants	Aeroshell/Royco Turbine Oil 500
American Oil and Supply Co.	American PQ Lubricant 6700
Castrol Inc.	Brayco 899
Hatcol Corporation	Hatcol 3211
Air BP Lubricants, Inc.	BP Turbo Oil 2380
Stauffer Chemical	Stauffer Jet II (Castrol 205)
Caltex Petroleum Corp.	Caltex RPM Jet Engine Oil 5
Chevron International Oil Co.	Chevron Jet Engine Oil 5
Exxon Mobil Corp.	Mobil Jet Oil 254 (Generation 3/HTS Oil)
Anderol Specialty Lubricants	Royco Turbine Oil 560 (Generation 3/HTS Oil)
Shell Oil Co.	Aeroshell Turbine Oil 560 (Generation 3/HTS Oil)

TABLE 8-2. APPROVED COMMERCIAL OILS (CONTINUED)

MIL-PRF-2105/API GL-5

MANUFACTURER	MANUFACTURER'S DESIGNATION
Exxon Mobil Corp.	Mobil 1 Synthetic Gear Lubricant LS 75W-90 Mobil Delvac 1[1] Synthetic Gear Oil 75W-90 Mobilube HD LS 80W-90 Mobilube HD Plus 80W-90
Shell Oil Company	Shell Spirax® S Gear Lubricant 75W-90 Shell Spirax® HD 80W-90
Esso	Esso Gear Oil GX 75W-90 Esso Gear Oil GX Extra 75W-90
BP Lubricants USA, Inc.	Syntorq GL-5 75W Castrol Syntrax Limited Slip 75W-90 (Syntec Gear Oil)

TABLE 8-3. APPROVED PRIMARY, EMERGENCY, AND COLD WEATHER FUELS

TYPE	SPECIFICATION	LIMITATIONS
Primary	ASTM D1655 Jet A or A1 ASTM D6615 Jet B MIL-DTL-5624 JP-4 & JP-5 MIL-DTL-83133 JP-8 GOST 10227 Grade TS-1 or RT (Russia) STAS 5639-88, Grade TH (Romania) GB 6537, Grade No. 3 (Peoples Republic of China) GSTU 320.00149943.007-97 Grade -RT(PT) (Ukraine) GSTU 320.00149943.007-99 Grade -TS-1(TC-1) (Ukraine)	With anti-ice additive **(See Note below)**
Emergency	ASTM D910 AVGAS (without TCP)	All Grades, Maximum 6 hours operation per overhaul period. With anti-ice additive
Cold Weather	MIL-DTL-5624 JP-4 ASTM D6615 Jet B ASTM D910 AVGAS-Jet fuel mixture **(See Note below)**	With anti-ice additive

[1] Mobil Delvac 1 75W-90 supersedes Mobil Delvac 75W-90 and Mobil SHC 75W-90.

NOTE

At ambient temperatures below 4°C (40°F), all fuels used shall contain Anti-Icing Additive conforming to MIL-DTL-85470. The Anti-Icing Additive shall be added to all commercial fuel, not already containing an anti-icing additive, during refueling operations. Refueling operations shall be accomplished in accordance with accepted commercial procedures. Commercial product PRIST® HI-FLASH™ conforms to MIL-DTL-85470.

NOTE

The AVGAS-jet fuel mixture is an alternate fuel which may be used if starting problems are encountered in areas where JP-4 or commercial Jet B cannot be obtained. The mixture shall be one part by volume AVGAS to two parts by volume commercial jet fuel. The AVGAS shall conform to ASTM D910, grades 80, 91, or 100LL with a maximum of 0.53 ml/liter maximum lead content. <u>Do Not</u> use ASTM D910 grade 100 with 1.06 ml/liter lead content. The commercial jet fuel may be JP-5, Jet A, or A1.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 9

SUPPLEMENTAL INFORMATION

SECTION I. GENERAL OPERATION

9-1. Starting The helicopter can be started in a maximum wind velocity, including peak gusts, of 45 knots. The maximum gust spread is 15 knots.

9-2. Engine Starting Acceleration Time. The engine should start and accelerate to idle within the times shown in Figure 9-1. If the start time becomes significantly longer than those shown in Figure 9-1, consult maintenance personnel.

9-3. Oil Consumption The maximum oil consumption allowed is 0.05 gallons/hour at normal cruise rated power. If oil consumption increases, consult maintenance personnel.

9-4. Control Movements Abrupt control movements should be avoided, including rapid and repetitive anti-torque pedal reversal. This restriction in no way limits normal control application.

9-5. Slope Landings Slope landings have been demonstrated with the slope 90 degrees either side of the nose up to a maximum of 15 degrees.

CAUTION

Caution must be exercised when landing on slopes that available cyclic travel is not exceeded. Also, if any droop stop pounding is encountered as the collective is lowered the landing must be aborted and a slope with less angle selected.

9-6. Minimum Transient Rotor Speed The minimum allowable transient rotor speed following engine failure or sudden power reduction for practice forced landing is 300 RPM. This is a transient limit and positive corrective action (lowering the collective) must be taken immediately by the pilot to regain at least 334 RPM (minimum power off rotor RPM). Lowering the collective to full down will quickly restore rotor RPM to the normal operating range under most flight conditions. Throttle chops or engine failure from the high hover point on the Height-Velocity (H-V) curve, along with the forward cyclic displacement required to achieve 20 degrees nose down attitude for recovery, may result in the rotor speed decreasing below the minimum power off rotor RPM limit but not below the minimum transient limit of 300 rotor RPM. The (H-V) curve was developed taking this characteristic into account so that proper energy is available to return the rotor to the normal operating range prior to touchdown.

9-7. Flight Over Salt Water Salt spray in turbine engines may result in a deterioration in performance as well as a loss in compressor stall margin. Flight in a salt water environment below 500 feet AGL and near a large body of salt water will also have an impact on engine health. Following any exposure to a salt water environment, ie. hovering over salt water or flight operations within 5 nautical miles of an ocean coastline below 500 feet AGL, appropriate entries should be made in the aircraft log book reflecting flight altitudes, duration of exposure, and other pertinent information so that maintenance personnel can perform an engine compressor wash and rinse the airframe with fresh water.

ESTIMATED PERFORMANCE ALLISON MODEL 250-C20W

ENGINE AVERAGE STARTING TIME WITH MIL-T-5624 GRADE JP-4 FUEL

AMBIENT PRESSURE - 29.92 IN. HG ABS.

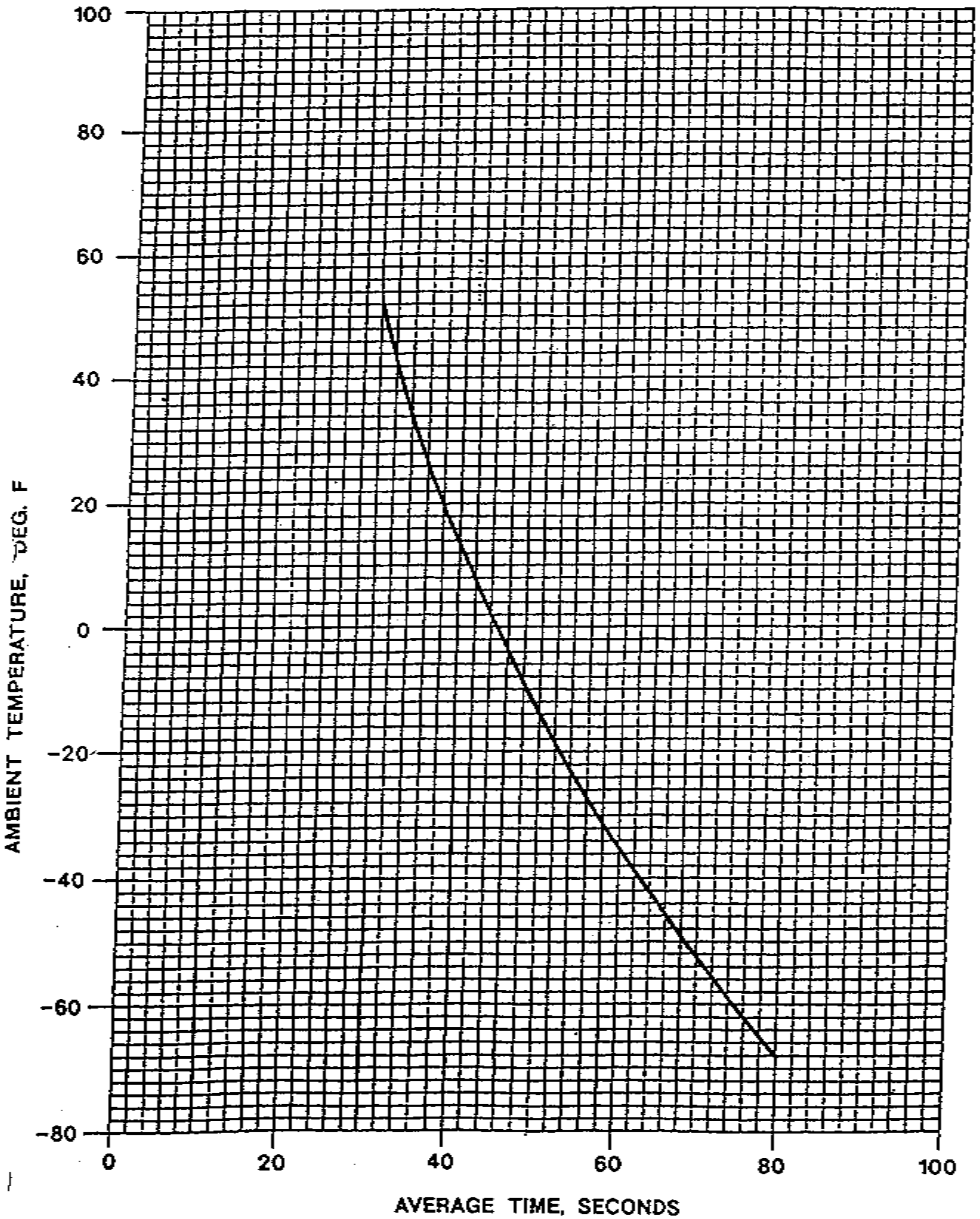


FIGURE 9-1. ENGINE AVERAGE STARTING TIME

9-8. Operating Characteristics

The flight characteristics of this helicopter, in general, are similar to other single rotor helicopters. This helicopter is capable of hovering in winds from any azimuth up to 35 knots.

9-9. Retreating Blade Stall

Blade stall occurs at higher forward speeds when a portion of the retreating blade stalls because of the reduced relative velocity of airflow over the blade at high blade angles. When the airspeed of the tip of the retreating blade falls below a predetermined value, or when a relative blade angle exceeds a predetermined value, blade stall will be experienced. If blade pitch is increased (as with increased collective or forward cyclic control), or if the forward speed is increased, the stalled portion of the rotor disc increases, and the stall progresses from the tip toward the root of the retreating blade. During maneuvers that increase the g-load, such as sharp turns or high-speed flares from diving descents, where rapid application of collective or cyclic pitch control is involved, severe blade stall may be encountered. Severe blade stall may also be encountered in turbulent air by gust-induced load factors or corrective control applications by the pilot. In the stall condition, each main rotor blade will stall as it passes through the stall region, creating a three per rev vibration. When significant blade stall is encountered a mild roughness will be noted along with some cyclic control feedback that will cause the cyclic to have a tendency to displace aft of the trimmed position. The vibration due to the blade stall will increase as blade stall progresses, as will the requirement for forward force to maintain the cyclic in the initial trimmed position. Both of these cues should provide adequate warning that blade stall is being encountered. Severe turbulence or abrupt control movement at this point will increase the severity of the stall but will not cause any loss of control to occur. In this helicopter, there is not as pronounced a tendency for the fuselage to pitch up and roll left in response to the rotor stalling as may be experienced in other helicopters, but if the rotor is held in a stalled condition and the blade stall is aggravated, the helicopter will eventually exhibit this pitch and roll tendency. Even though blade stall may be encountered, the helicopter is fully controllable even in severe blade stall because of the blade design and the high rotor control power inherent in this rotor design. Blade stall may be eliminated by any or all of the following actions:

a. Gradually decrease the severity of the maneuver.

b. Gradually decrease collective pitch.

c. Gradually decrease airspeed.

d. Increase the rotor speed to maximum power on RPM by beeping the engine to 103% N_2.

9-10. Vortex Ring State (Settling With Power)

CAUTION

Flight conditions causing Vortex Ring State should be avoided at low altitudes because of the loss of altitude necessary for recovery.

Vortex Ring State may occur when a helicopter is flown at low airspeeds using a relatively high power setting and at relatively low rates of descent. Under this condition, the helicopter is descending through the air displaced by its own rotor system. The downwash then recirculates through the helicopter rotor system and results in reduced rotor efficiency. This condition can be recognized by increased roughness accompanied by a rapid build-up in rate of descent. Increasing collective pitch alone only tends to aggravate the situation. The Vuichard technique is very effective at recovering from settling with power. This technique uses the tail rotor thrust and the cyclic to move the advancing blade into clear air, at which point the vortex ring will dissipate. Recovery can be completed with much less altitude loss than with traditional techniques.

The Vuichard technique can be performed as follows:

a. Simultaneously, apply sufficient right cyclic to cause a 10° to 20° bank, apply left pedal to maintain heading, and increase collective.

During approach for landings at high gross weights, conditions associated with Vortex Ring State should be avoided.

9-11. Loss of Tail Rotor Effectiveness

Loss of tail rotor effectiveness (LTE) is a phenomenon which can occur in any single main rotor/anti-torque tail rotor helicopter. Although the 480B has a very effective tail rotor and does not exhibit any tendencies for LTE, the pilot should be aware that the potential for LTE, however small, does exist. As such, pilots should be aware of the causes and recovery techniques.

There are a number of factors which reduce the effectiveness of the tail rotor or increase the thrust required from the tail rotor. These factors include high power settings, low airspeeds, left crosswinds or tailwinds, and right, yawing turns. Under exactly the right conditions, these factors can combine to make the tail rotor virtually ineffective. This LTE can be recognized by an uncommanded right yaw which can not be stopped using the tail rotor pedal alone. Recovery from LTE can be accomplished by increasing forward speed, lowering the collective if altitude permits, and applying left pedal. The longer corrective actions are delayed, the more difficult it will be to recover from LTE.

9-12. Ground Resonance

Ground resonance is an aerodynamic phenomenon associated with fully articulated rotor systems. It develops when the rotor blades move out of phase with each other and cause the rotor disc to become unbalanced. The chance of encountering ground resonance in the 480B is very remote; however, the potential does exist if the main rotor dampers or oleo struts are severely degraded or damaged.

If severe vibrations are encountered on the ground when bringing the main rotor rpm up to operating speed, immediately turn the throttle to the flight idle position. If severe vibrations are encountered when the main rotor rpm is at operating speed, immediately hover the aircraft and allow the vibrations to dampen. Attempt to land the aircraft. If severe vibrations are encountered again, immediately hover the aircraft, allow the vibrations to dampen, and perform a hovering autorotation.