Safety Regulation Group

Civil Aviation Authority

CAP 758

Helicopter Manual for JAR-FCL Examinations

Mass and Balance – Performance – Flight Planning and Monitoring

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Revision History

1st Edition **March 2009**

This manual has been produced to support training and examinations in JAR-FCL subject 030 for helicopters including 031 – Mass and Balance, 033 – Flight Planning and Monitoring and 034 – Performance.

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Section 1 General Notes

1 Introduction

1.1 This manual is intended for the use of candidates for the JAR-FCL 2 Theoretical Knowledge Examinations.

1.2 All data contained within this manual is for examination purposes only.

1.3 The data must not be used for any other purpose and specifically, **is not to be used for the purpose of planning activities associated with the operation of any helicopter.**

2 Aircraft Description

The helicopters used in this manual are of generic types related to the classes of helicopter on which the examinations are based.

Generic Helicopters:

Single-Engine Piston Helicopter (**SEPH**) (see Section 2)
Twin-Engine Turbine Helicopter (**TETH**) (see Section 3)

3 Layout of Data Sheets

3.1 The selected pages used in this manual for the generic helicopters SEPH and TETH are not complete with all sections. Only those sections required for examination purposes in subject 030 are included.

3.2 In all of its documents the JAA use the term mass whereas the majority of aviation documents produced by the manufacturers use the term weight. The following are definitions of each of the terms and should help clarify the situation:

Mass. The quantity of matter in a body as measured by its inertia is referred to as its mass. It determines the force exerted on that body by gravity, which is inversely proportional to the mass. Gravity varies from place to place and also decreases with increased altitude above mean sea level.

Weight. The force exerted on a body by gravity is known as its weight and is dependent for its value on the mass of the body and the strength of the gravitational force. Weight = mass in kg × gravity in Newtons. Thus the weight of a body varies with its position and elevation above mean sea level but the mass does not change for the same body.

For the purposes of this manual the terms weight and mass are interchangeable. In the questions asked in the JAA examinations the word mass is used most of the time whereas in CAP 758, the term weight is used on some of the pro-formas reproduced herein (see *JAR-OPS 3 ACJ OPS 1.605*).

4 Definitions

Definitions given in italics are not given in ICAO, JAA or EASA documentation but are in common use.

Allowed Take-Off Mass	*The mass taking into consideration all possible limitations for take-off including restrictions caused by Regulated Take-Off Mass and Regulated Landing Mass.*
Area Load or Floor Load	The load (or mass) distributed over a defined area. Units of measurement used: SI: N/m^2, kg/m^2 Non-SI: psi, lb/ft^2
Basic Empty Mass	*The mass of a helicopter plus standard items such as: unusable fuel; full operating fluids; fire extinguishers; emergency oxygen equipment.*
Dry Operating Mass	The total mass of a helicopter ready for a specific type of operation excluding all usable fuel and traffic load. This mass includes items such as: • crew and crew baggage; • catering and removable passenger service equipment; • potable water and lavatory chemicals; • food and beverages; • rescue hoist, cargo sling, etc.
In-Flight Mass	*The mass of a helicopter in flight at a specified time.*
Landing Mass	The mass of the helicopter at landing.
Maximum Structural In-Flight Mass with External Loads	*The maximum permissible total mass of the helicopter with external loads.*
Maximum Structural Landing Mass	The maximum permissible total mass of the helicopter on landing under normal circumstances.
Maximum Structural Mass	*The maximum permissible total mass of the helicopter at any time. It will be given only if there is no difference between Maximum Structural Taxi Mass, Maximum Structural Take-Off Mass and Maximum Structural Landing Mass.*
Maximum Structural Take-Off Mass	The maximum permissible total mass of the helicopter at commencement of take-off.
Maximum Structural Taxi Mass	*The maximum permissible total mass of the helicopter at commencement of taxi.*
Maximum Structural Towing Mass	The maximum permissible total mass of the helicopter being towed on the ground.

Minimum Mass	*The minimum permissible total mass for the helicopter operation.*
Operating Mass	The Dry Operating Mass plus fuel but without traffic load.
Performance Limited Landing Mass	*The mass subject to the destination airfield limitations. It must never exceed the maximum structural limit.*
Performance Limited Take-Off Mass	The take-off mass subject to departure airfield limitations. It must never exceed the maximum structural limit.
Regulated Landing Mass	*The lower of Performance Limited Landing Mass and Maximum Structural Landing Mass.*
Regulated Take-Off Mass	The lower of Performance Limited Take-Off Mass and Maximum Structural Take-Off Mass.
Running (or Linear) Load	*The load (or mass) distributed over a defined length of a cargo compartment irrespective of load width. Units of measurement used:* *SI: N/m, kg/m* *Non-SI: lb/in, lb/ft*
Take-Off Fuel	The total amount of usable fuel at take-off.
Take-Off Mass	*The mass of the helicopter including everything and everyone contained within it at the commencement of take-off.*
Taxi Mass	The mass of the helicopter at the commencement of taxi.
Traffic Load	*The total mass of passengers, baggage and cargo, including any non-revenue load.*
Trip Fuel	The fuel on board to complete the flight. It includes: • fuel for take-off and climb from the heliport elevation to the initial cruising level/altitude, taking into account the expected departure routing; • fuel from the top of climb to the top of descent, including any step climb/descent; • fuel from the top of descent to the point at which the approach procedure is initiated, taking into account the expected arrival procedure; • fuel for the approach and landing at the destination heliport.

Useful Load	*The total mass of the passengers, baggage and cargo, including any non-revenue load and usable fuel.* *It is the difference between the Dry Operating Mass and the Take-Off Mass.*
Zero Fuel Mass	The Dry Operating Mass plus traffic load but excluding fuel.

5 Symbols and Abbreviations

Altitudes/Heights

- Critical decision height	h1
- Density Altitude	H σ
- Pressure Altitude	H p
- Take-off or landing height	h

Speeds

- Calibrated airspeed	CAS
- Critical decision speed	V_1
- Indicated airspeed	IAS
- Never exceed speed	V_{NE}
- Optimum climbing speed	V_Y
- Rate of climb	ROC
- Rate of descent	ROD
- Take-off safety speed	V_{TOSS}
- True airspeed	TAS
- Wind velocity	V_W

Temperatures

- Exhaust gas temperature	EGT or T4
- Outside air temperature	OAT

Miscellaneous

- Barometric pressure	P o
Centre of Gravity	CG
- Free turbine speed	N f
- Gas generator speed	N g
- Main gearbox / Tail gearbox	MGB / TGB
- Nautical mile	NM
- Out of ground effect / In ground effect	OGE / IGE

- Power W
- Rotor speed NR
- Statute mile SM
- Torque c

6 Conversion Tables

6.1 Speed

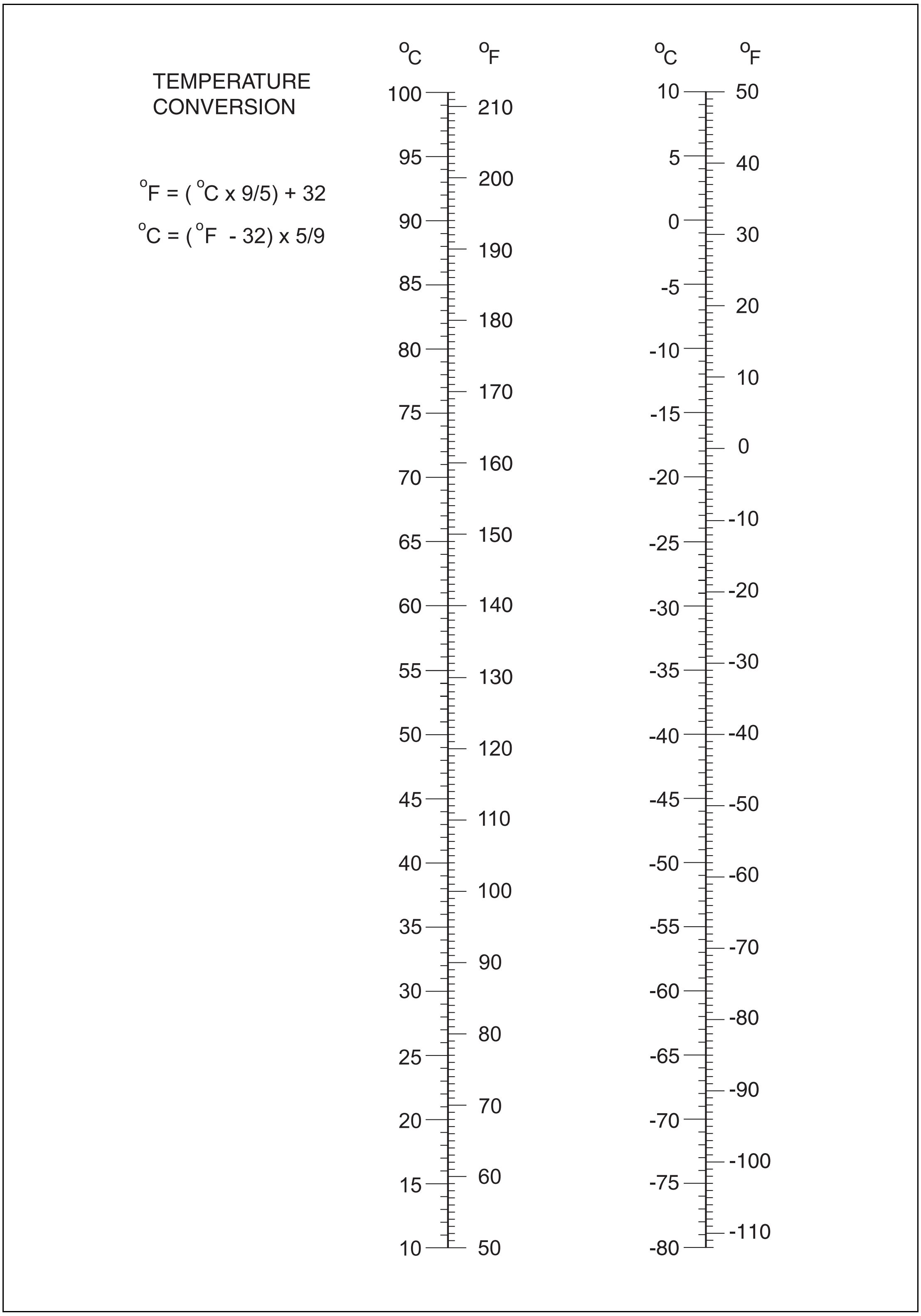
Speeds shown in Table 1.1 are straight mathematical conversions of Knots (kt) to Miles per Hour (mph) and Kilometres per Hour (km/h) rounded to the nearest whole number.

Table 1.1 Speed

kt	mph (approx.)	km/h (approx.)	kt	mph (approx.)	km/h (approx.)
1	1	2	**20**	23	37
2	2	4	**30**	35	56
3	3	6	**40**	46	74
4	5	7	**50**	58	93
5	6	9	**60**	69	111
6	7	11	**70**	81	130
7	8	13	**80**	92	148
8	9	15	**90**	104	167
9	10	17	**100**	115	185
10	12	19	**110**	127	204
1 kt = 1.15 mph or 1.85 km/h					

6.2 Temperature

Table 1.2 Temperature – $^{o}F/^{o}C$



EXAMPLE: $15^{o}C = 59.0^{o}F$ **OR** $15^{o}F = -9.4^{o}C$

6.3 Liquid Measure

Table 1.3 Liquid Measure – gal/l

U.S. Gallons to Litres

gals → / gals ↓	0 litres	1 litres	2 litres	3 litres	4 litres	5 litres	6 litres	7 litres	8 litres	9 litres
0		3.785	7.571	11.356	15.142	18.927	22.713	26.498	30.283	34.069
10	37.854	41.640	45.425	49.211	52.996	56.781	60.567	64.352	68.138	71.923
20	75.709	79.494	83.280	87.065	90.850	94.636	98.421	102.21	105.99	109.78
30	113.56	117.35	121.13	124.92	128.70	132.49	136.28	140.06	143.85	147.63
40	151.42	155.20	158.99	162.77	166.56	**170.34**	174.13	177.92	181.70	185.49
50	189.27	193.06	196.84	200.63	204.41	208.20	211.98	215.77	219.56	223.34
60	227.13	230.91	234.70	238.48	242.27	246.05	249.84	253.62	257.41	261.19
70	264.98	268.77	272.55	276.34	280.12	283.91	287.69	291.48	295.26	299.05
80	302.83	306.62	310.41	314.19	317.98	321.76	325.55	329.33	333.12	336.90
90	340.69	344.47	348.26	352.05	355.83	359.62	363.40	367.19	370.97	374.76
100	378.54	382.33	386.11	389.90	393.69	397.47	401.26	405.04	408.83	412.61

NOTE: The horizontal "gals" column represents 1 to 9 gallons
The vertical "gals" column represents 10 to 100 gallons

EXAMPLE: 45 gallons = 170.34 litres
(follow 40 gals line to right to intersect with 5 gals column)

6.4 Linear Measure

Table 1.4 Linear Measure – in/cm

Inches to Centimetres

inches → / inches ↓	0 cm	1 cm	2 cm	3 cm	4 cm	5 cm	6 cm	7 cm	8 cm	9 cm
0		2.54	5.08	7.62	10.16	12.70	15.24	17.78	20.32	22.86
10	25.40	27.94	30.48	33.02	35.56	38.10	40.64	43.18	45.72	48.26
20	50.80	53.34	55.88	58.42	60.96	63.50	66.04	68.58	71.12	73.66
30	76.20	78.74	81.28	83.82	86.36	88.90	91.44	93.98	96.52	99.06
40	101.60	104.14	106.68	109.22	111.76	**114.30**	116.84	119.38	121.92	124.46
50	127.00	129.54	132.08	134.62	137.16	139.70	142.24	144.78	147.32	149.86
60	152.40	154.94	157.48	160.02	162.56	165.10	167.64	170.18	172.72	175.26
70	177.80	180.34	182.88	185.42	187.96	190.50	193.04	195.58	198.12	200.66
80	203.20	205.74	208.28	210.82	213.36	215.90	218.44	220.98	223.52	226.06
90	228.60	231.14	233.68	236.22	238.76	241.30	243.84	246.38	248.92	251.46
100	254.00	256.54	259.08	261.62	264.16	266.70	269.24	271.78	274.32	276.86

NOTE: The horizontal "inches" column represents 1 to 9 inches
The vertical "inches" column represents 10 to 100 inches

EXAMPLE: 45 inches = 114.30 centimetres
(follow 40 inches line to right to intersect with 5 inches column)

Table 1.5 Linear Measure – ft/m

Feet to Metres

feet → / ↓	0 metres	1 metres	2 metres	3 metres	4 metres	5 metres	6 metres	7 metres	8 metres	9 metres
0		0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743
10	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.466	5.791
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.229	8.534	8.839
30	9.144	9.449	9.753	10.058	10.363	10.668	10.972	11.277	11.582	11.997
40	12.192	12.496	12.801	13.106	13.411	**13.716**	14.020	14.325	14.630	14.935
50	15.239	15.544	15.849	16.154	16.459	16.763	17.068	17.373	17.678	17.983
60	18.287	18.592	18.897	19.202	19.507	19.811	20.116	20.421	20.726	21.031
70	21.335	21.640	21.945	22.250	22.555	22.859	23.164	23.469	23.774	24.070
80	24.383	24.688	24.993	25.298	25.602	25.907	26.212	26.517	26.822	27.126
90	27.431	27.736	28.041	28.346	28.651	28.955	29.260	29.565	29.870	30.174
100	30.479	30.784	31.089	31.394	31.698	32.003	32.308	32.613	32.918	33.222

NOTE: The horizontal "feet" column represents 1 to 9 feet
The vertical "feet" column represents 10 to 100 feet

EXAMPLE: 45 feet = 13.716 metres
(follow 40 feet line to right to intersect with 5 feet column)

6.5 Mass Measure

Table 1.6 Mass Measure – lb/kg

Pounds to Kilograms

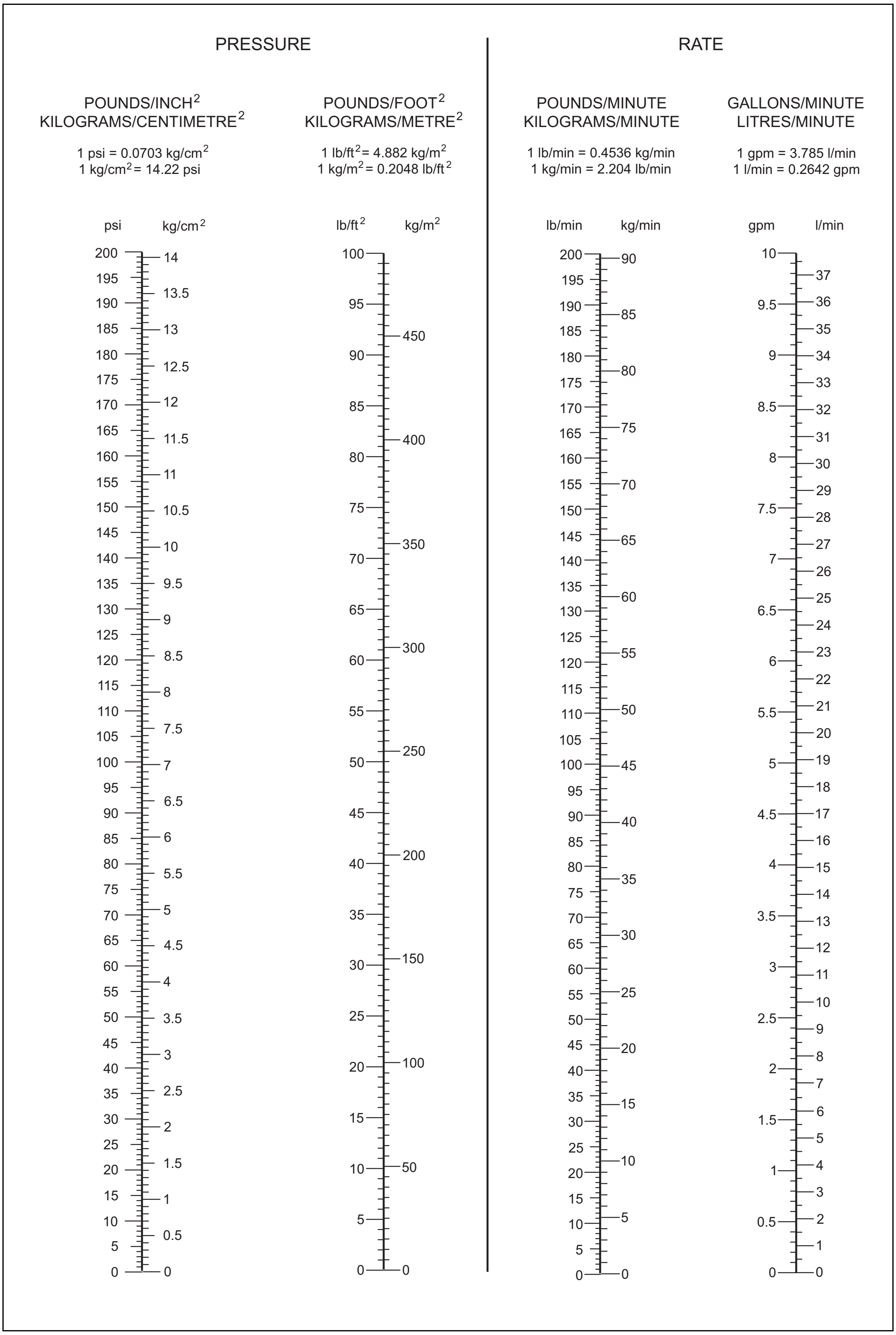
lbs → / ↓	0 kg	1 kg	2 kg	3 kg	4 kg	5 kg	6 kg	7 kg	8 kg	9 kg
0		0.454	0.907	1.361	1.814	2.268	2.722	3.175	3.629	4.082
10	4.536	4.990	5.443	5.897	6.350	6.804	7.257	7.711	8.165	8.618
20	9.072	9.525	9.979	10.433	10.886	11.340	11.793	12.247	12.701	13.154
30	13.608	14.061	14.515	14.969	15.422	15.876	16.329	16.783	17.237	17.690
40	18.144	18.597	19.051	19.504	19.958	**20.412**	20.865	21.319	21.772	22.226
50	22.680	23.133	23.587	24.040	24.494	24.948	25.401	25.855	26.308	26.762
60	27.216	27.669	28.123	28.576	29.030	29.484	29.937	30.391	30.844	31.298
70	31.751	32.205	32.659	33.112	33.566	34.019	34.473	34.927	35.380	35.834
80	36.287	36.741	37.195	37.648	38.102	38.555	39.009	39.463	39.916	40.370
90	40.823	41.277	41.730	42.184	42.638	43.091	43.545	43.998	44.453	44.906
100	45.359	45.813	46.266	46.720	47.174	47.627	48.081	48.534	48.988	49.442

NOTE: The horizontal "lbs" column represents 1 to 9 pounds
The vertical "lbs" column represents 10 to 100 pounds

EXAMPLE: 45 pounds = 20.412 kilograms
(follow 40 lbs line to right to intersect with 5 lbs column)

6.6 Pressure and Rate

Table 1.7 Pressure and Flow Rate Conversion



6.7 Pressure Altitude to Density Altitude Conversion

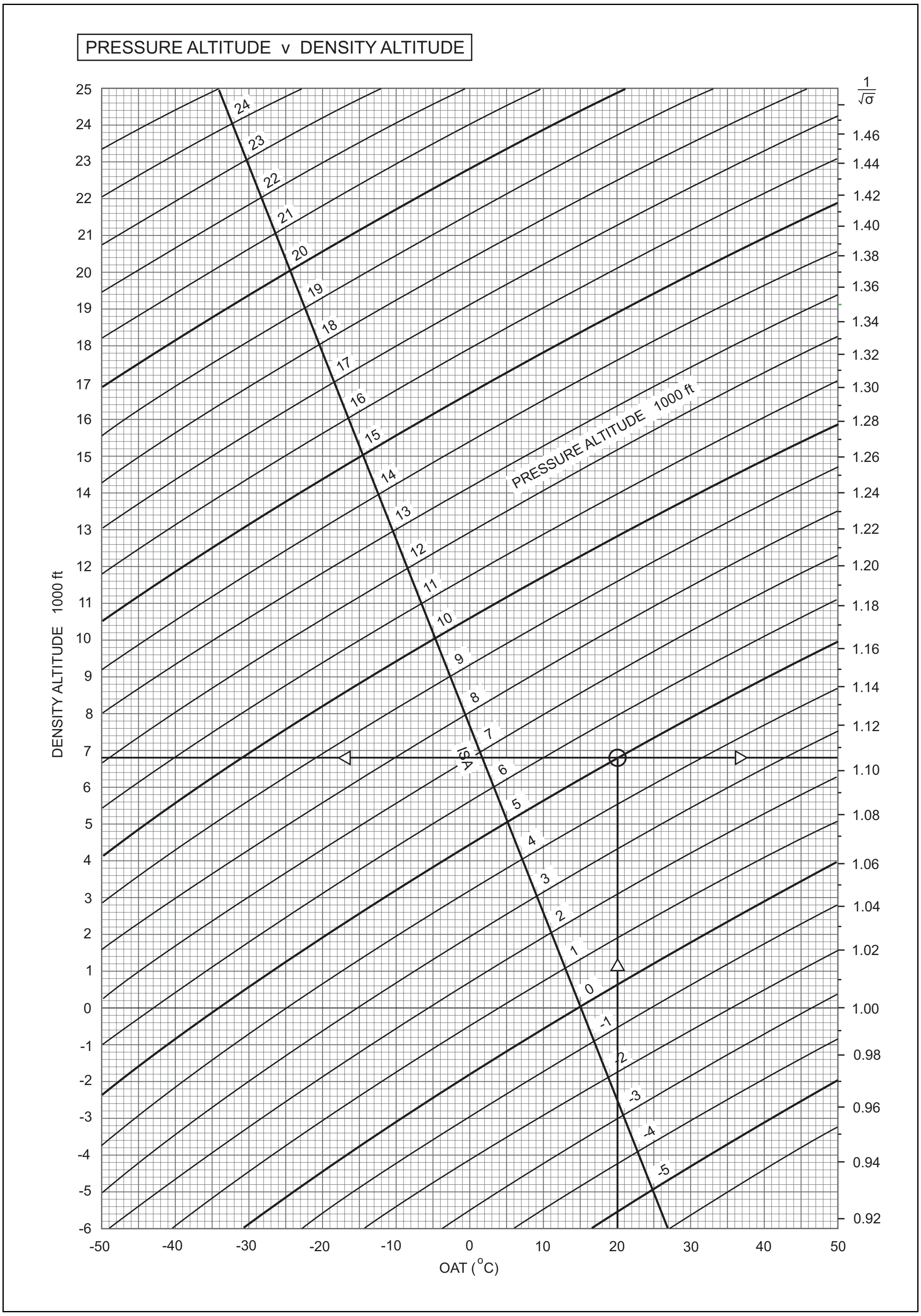


Figure 1.1 Pressure Altitude v. Density Altitude Chart

Section 2 Pilot's Flight Manual – SEPH

1 General

1.1 SEPH – Principal Dimensions

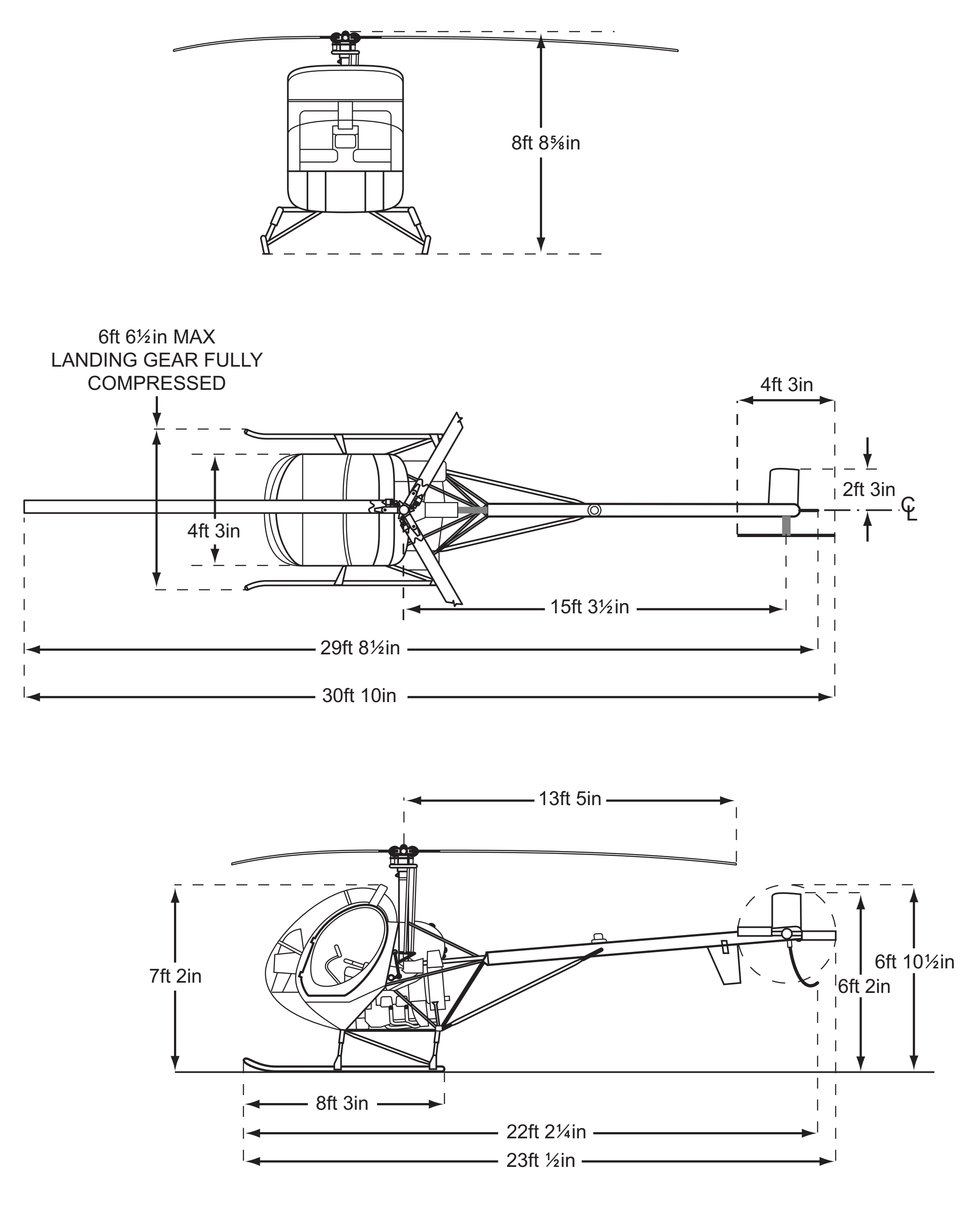


Figure 2.1 SEPH – Principal Dimensions

2 Limitations

2.1 Power Plant Limitations

- Maximum continuous power is 190 horsepower at 3,200 rpm with 26.0 in of manifold pressure (MP) at sea level. This varies linearly to 24.7 in MP at 4,200 ft altitude for a Standard day. Refer to manifold pressure placard.
- The minimum rpm is 3,000.
- The range for engine idle speed is 1,200 to 1,600 rpm.
- With rotor disengaged, avoid engine idle speed in excess of 1,600 rpm.

CAUTION

IF ENGINE RPM EXCEEDS 2,000 RPM WITH ROTOR DISENGAGED, INSPECTION OF DRIVE SHAFT IS REQUIRED BEFORE ANY FUTURE OPERATION.

- The initial clutch engagement speeds are 1,500 to 1,600 rpm.

2.2 Fuel System

- Fuel Capacity (see Table 2.1).

Table 2.1 Fuel Capacity

Tank	Quantity	Useable Quantity
Main	33 U.S. gallons	32.5 U.S. gallons
Aux	19 U.S. gallons	18.8 U.S. gallons
Total	52 U.S. gallons	51.3 U.S. gallons

2.3 Auxiliary Fuel Tank Calibration

- Auxiliary Fuel Quantity (see Table 2.2).

Table 2.2 Auxiliary Fuel Quantity in U.S. Gallons

Gauge	0	5	10	15	20	25	30
Total	0	10	18	27	34	42	49

3 Performance

3.1 Performance Data

NOTE: The following performance figures are based on normal gross mass (2,050 pounds) and standard day conditions:

Best ROC speed:	41 kt (47 mph) IAS
Hovering ceiling:	5,900 ft altitude (2-ft skid height)

Controllability has been shown to be adequate in 17 kt (20 mph) winds from any direction.

IAS corrected for position and instrument error equals CAS. (See Figure 2.2, Airspeed Calibration Curve.)

3.2 Airspeed Calibration Curve

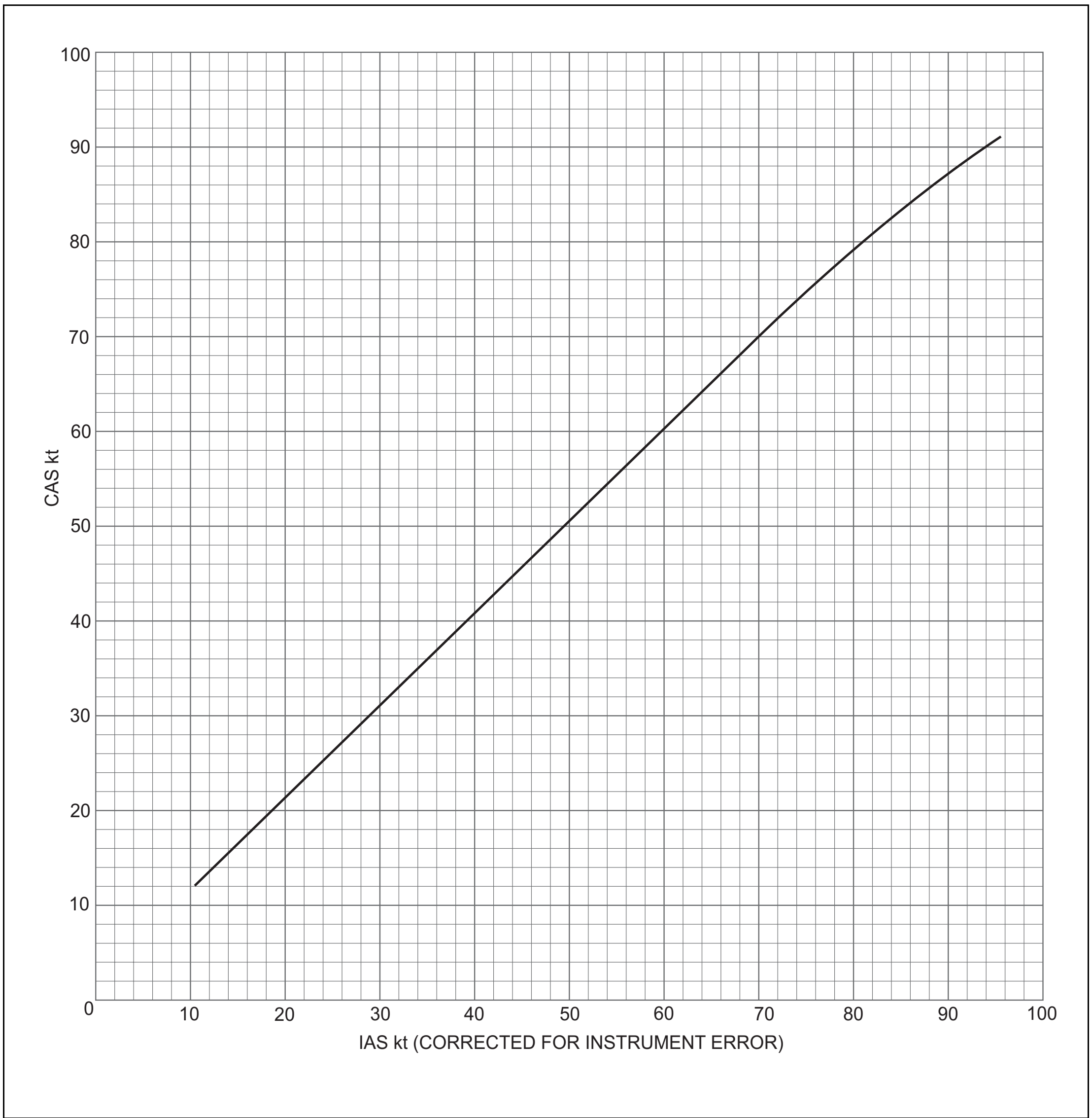


Figure 2.2 Airspeed Calibration Curve

3.3 Maximum Permitted Speed IAS

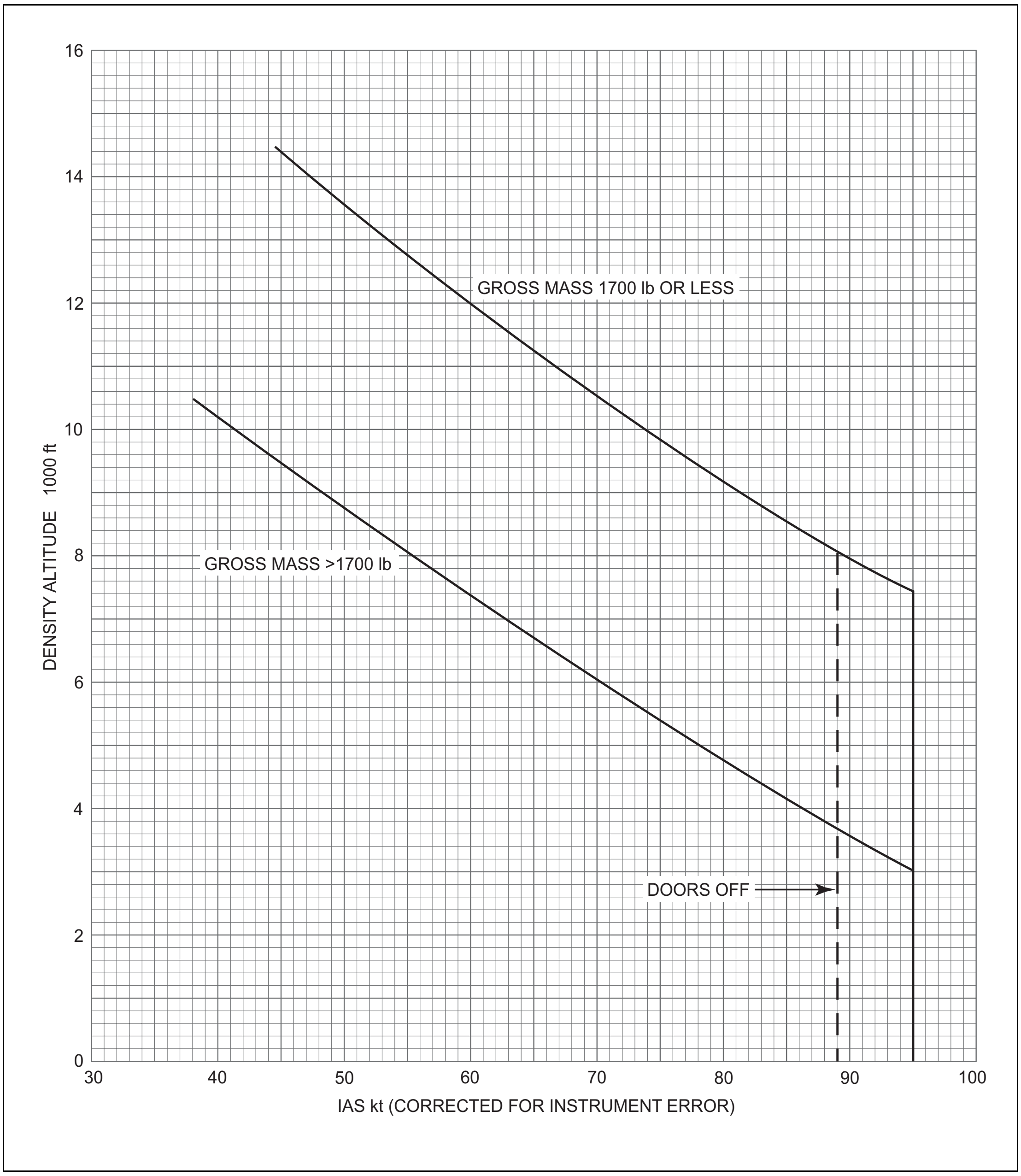


Figure 2.3 Variation of V_{NE} with Altitude

3.4 Height v. Velocity at Sea Level

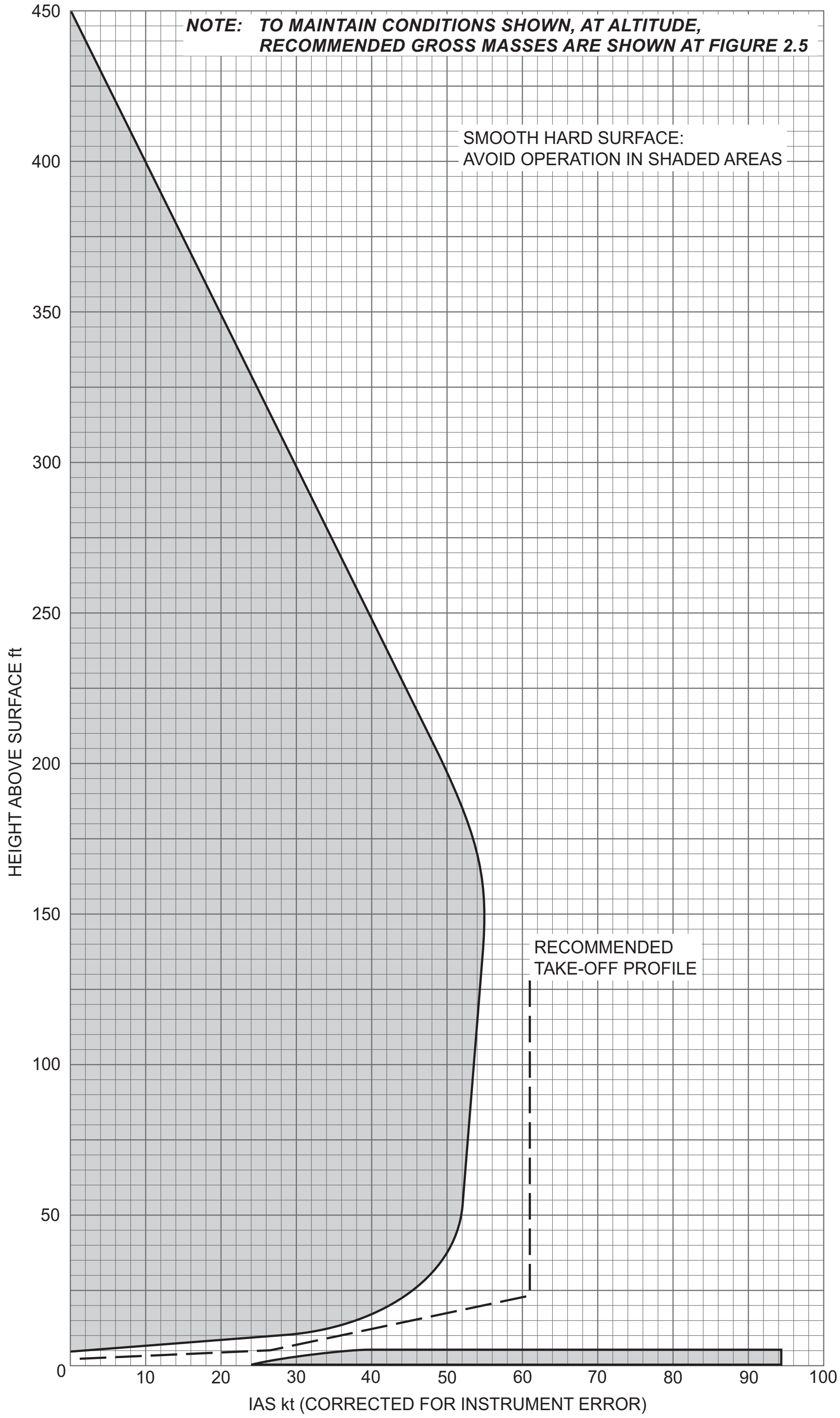


Figure 2.4 Height v. Velocity at Sea Level

3.5 Gross Mass v. Density Altitude at Take-Off

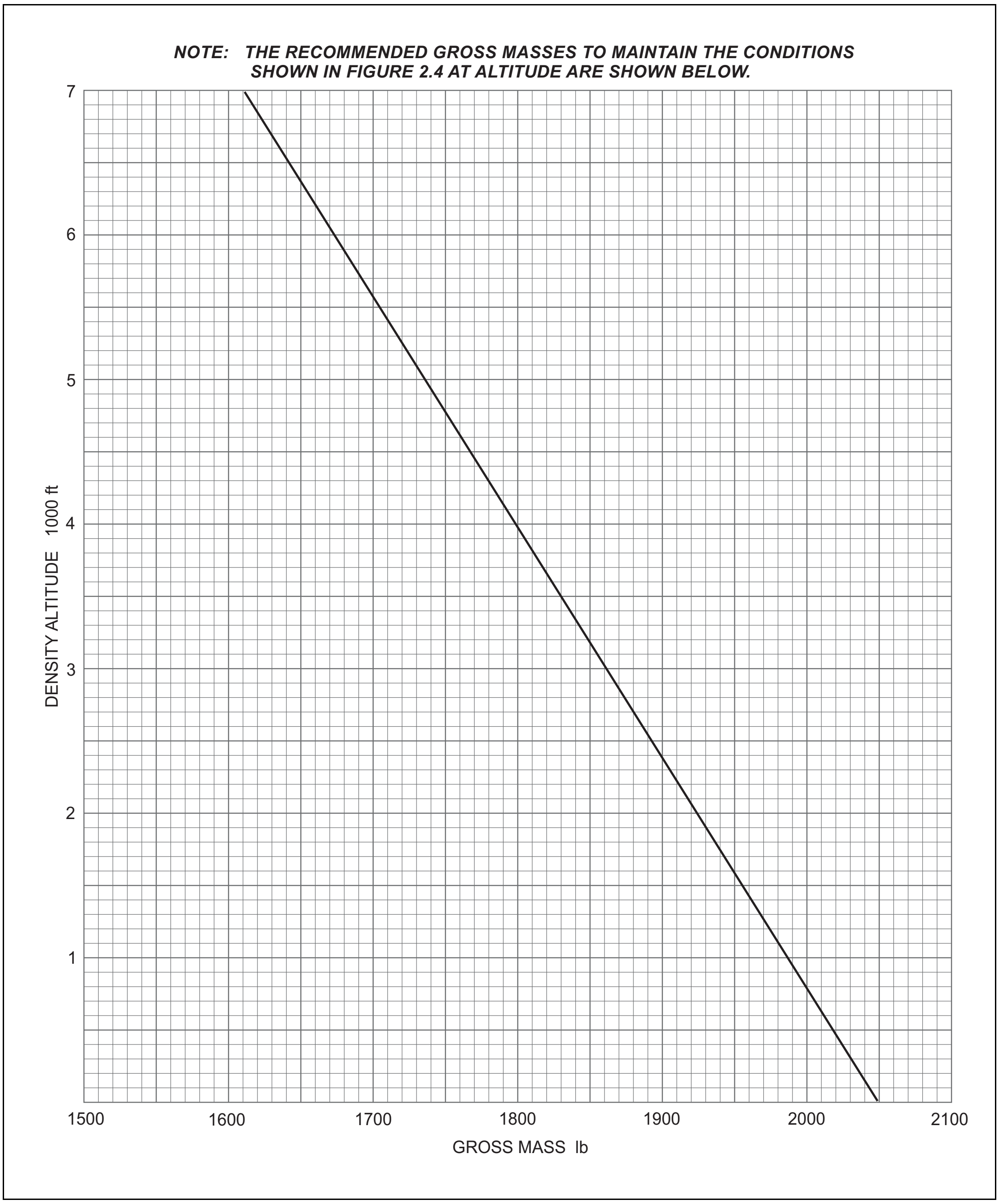


Figure 2.5 Gross Mass v. Density Altitude at Take-Off

3.6 Hover Ceiling v. Gross Mass (2-ft Skid Height, 3,200 rpm) IGE

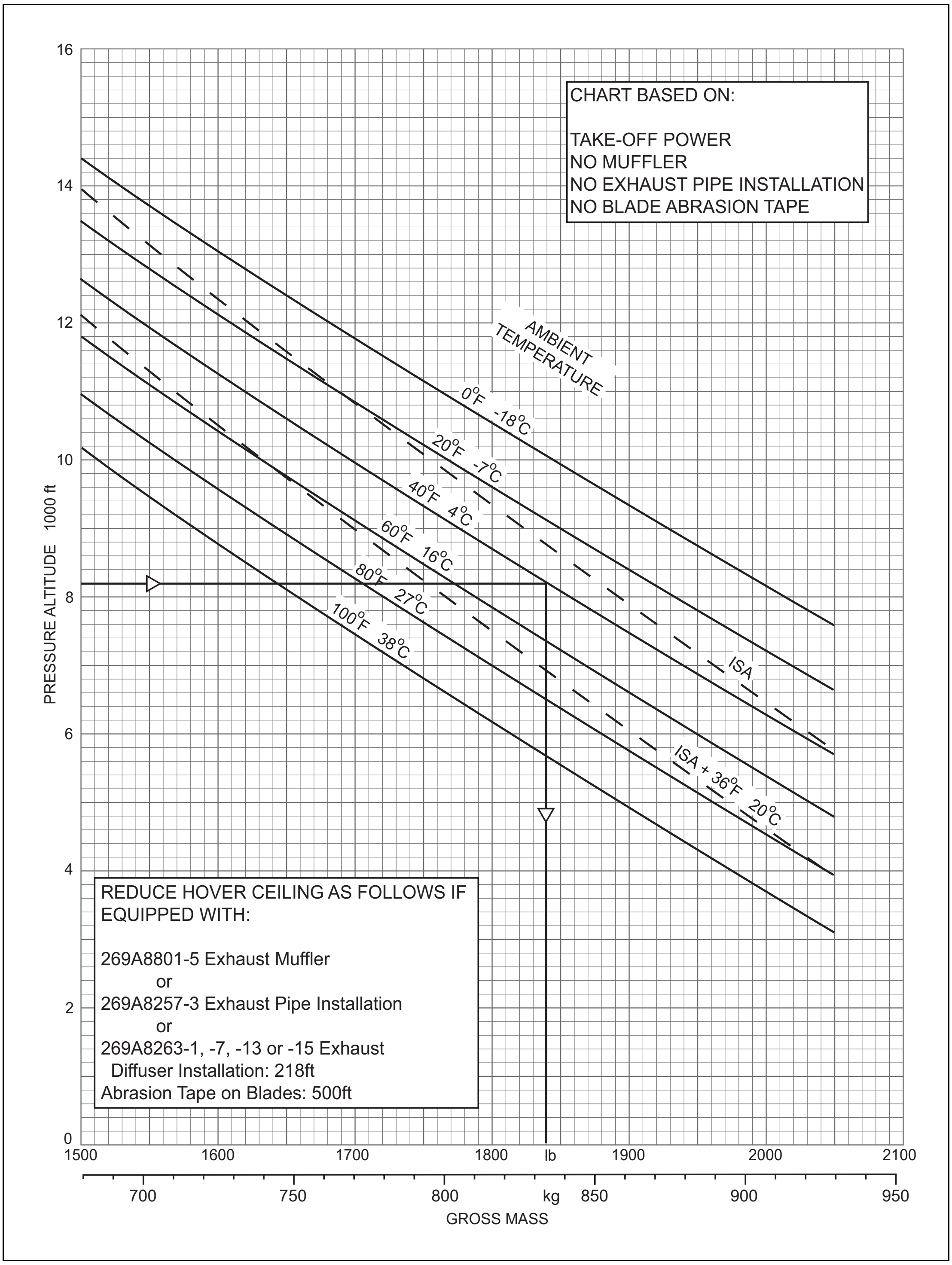


Figure 2.6 Hover Ceiling v. Gross Mass (2-ft Skid Height, 3,200 rpm) IGE

3.7 Hover Ceiling v. Gross Mass (2-ft Skid Height, 3,200 rpm, 80% Relative Humidity) IGE

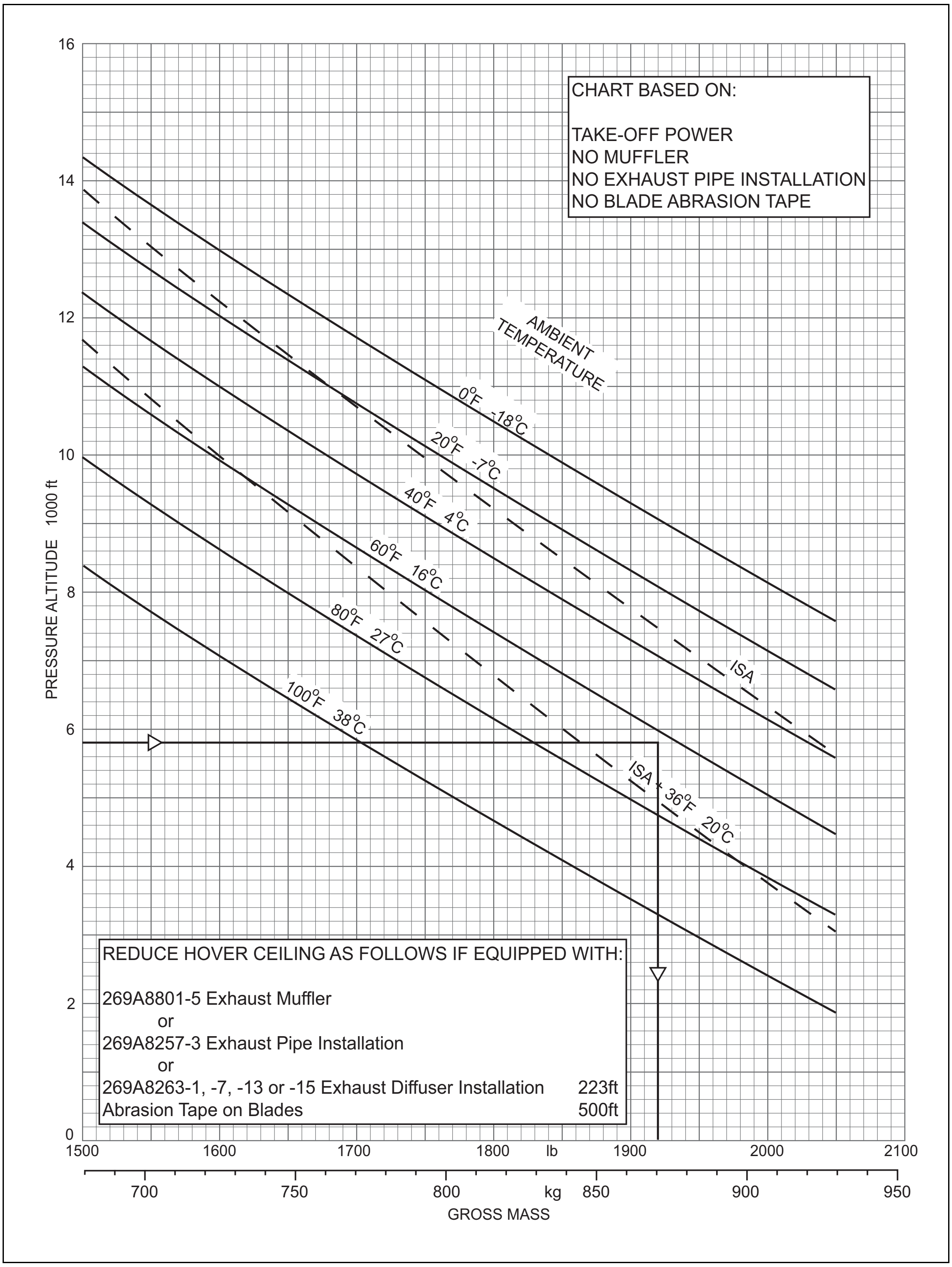


Figure 2.7 Hover Ceiling v. Gross Mass (2-ft Skid Height, 3,200 rpm, 80% Relative Humidity) IGE

3.8 Hover Ceiling v. Gross Mass (2-ft Skid Height, 3,000 rpm) IGE

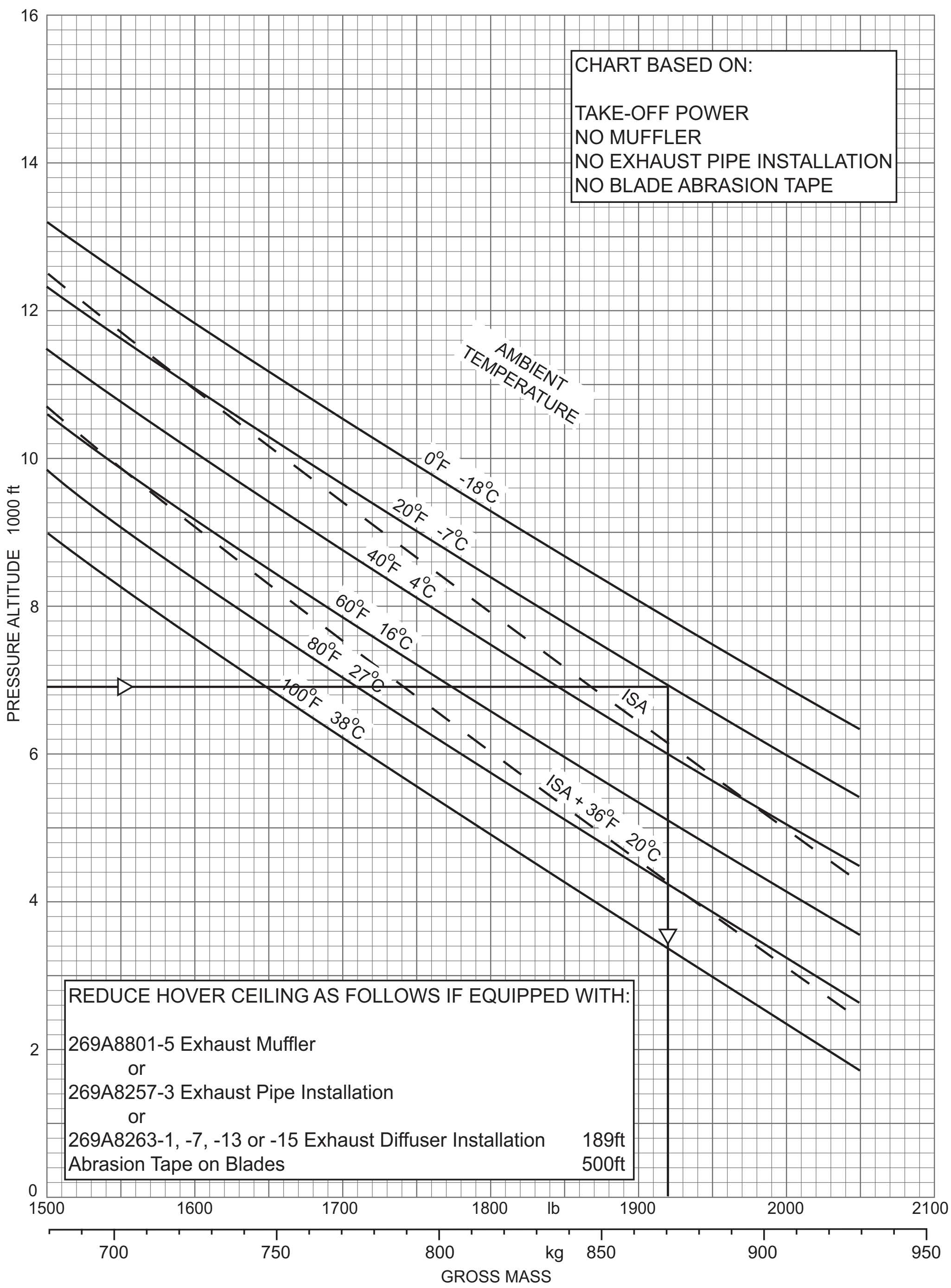


Figure 2.8 Hover Ceiling v. Gross Mass (2-ft Skid Height, 3,000 rpm) IGE

4 Mass and Balance

4.1 Mass and Balance Data – Introduction

All helicopters are designed for certain limit loads and balance conditions. Changes in equipment which affect the empty mass and empty mass CG must be entered on the FAA Major Repair and Alteration form (FAA Form 337), in accordance with Federal Air Regulations, which shall then become part of the helicopter file.

NOTE: Lateral and longitudinal CG must be controlled. Refer to Flight Manual addendums and Supplements provided for special instructions regarding mass and balance data.

4.2 Mass and Balance Characteristics

The removal or addition of fuel or equipment results in changes to the CG and mass of the helicopter, and the permissible load is affected accordingly. The effect of these changes must be investigated in all cases to eliminate possible adverse consequences on the helicopter's flight characteristics. The horizontal reference 'Datum' is located 100 inches forward of the centreline of the main rotor (see Figure 2.10). For convenience, Station 100 is marked on the helicopter. The forward lower edge of the lower stabiliser is Station 252.3. Station numbers correspond to an inch scale and may be used to locate equipment on the helicopter. The lateral 'Datum' is the centreline of the helicopter through the main rotor. The mass and balance characteristics are as follows:

- Maximum Gross Mass 2,050 lb.
- Longitudinal CG Limits (see Figure 2.9):

  Forward CG limit Station = 95.0

  Aft CG limit Station = 101.0

  NOTE: Datum line is 100 inches forward of rotor centreline.
- Lateral CG limits (see Figure 2.9):

At Station 95:	+3.0 to -1.0
At Station 99.5:	+4.0 to -2.12
At Station 101:	+2.0 to -2.5

Lateral variations between corners: plus ('+') is right of centreline, minus ('-') is left of centreline of helicopter when viewing forward (see Figure 2.11).

NOTE: The lateral datum line is the centreline of the helicopter through the main rotor.

4.3 CG Envelope

The permissible range of longitudinal and lateral CG travel is illustrated in Figure 2.9.

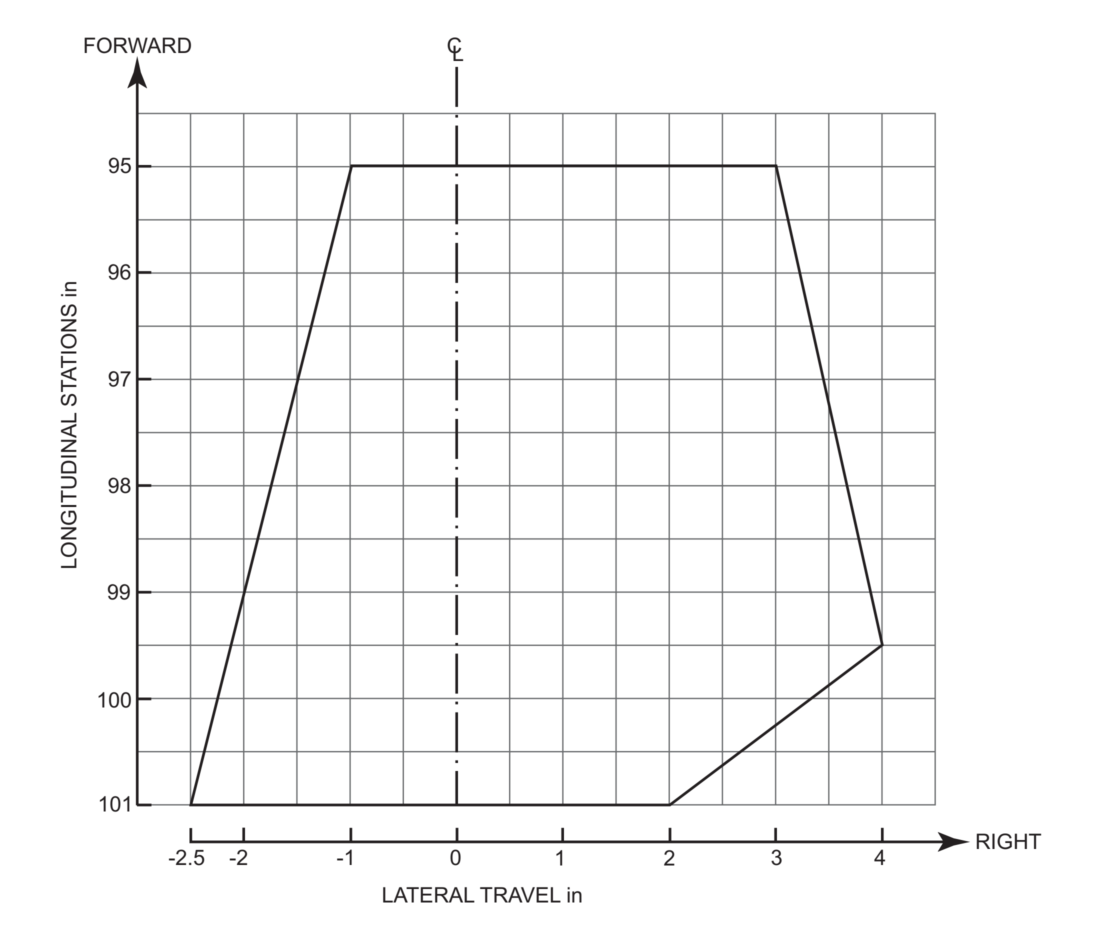


Figure 2.9 CG Envelope

4.4 Station Diagram

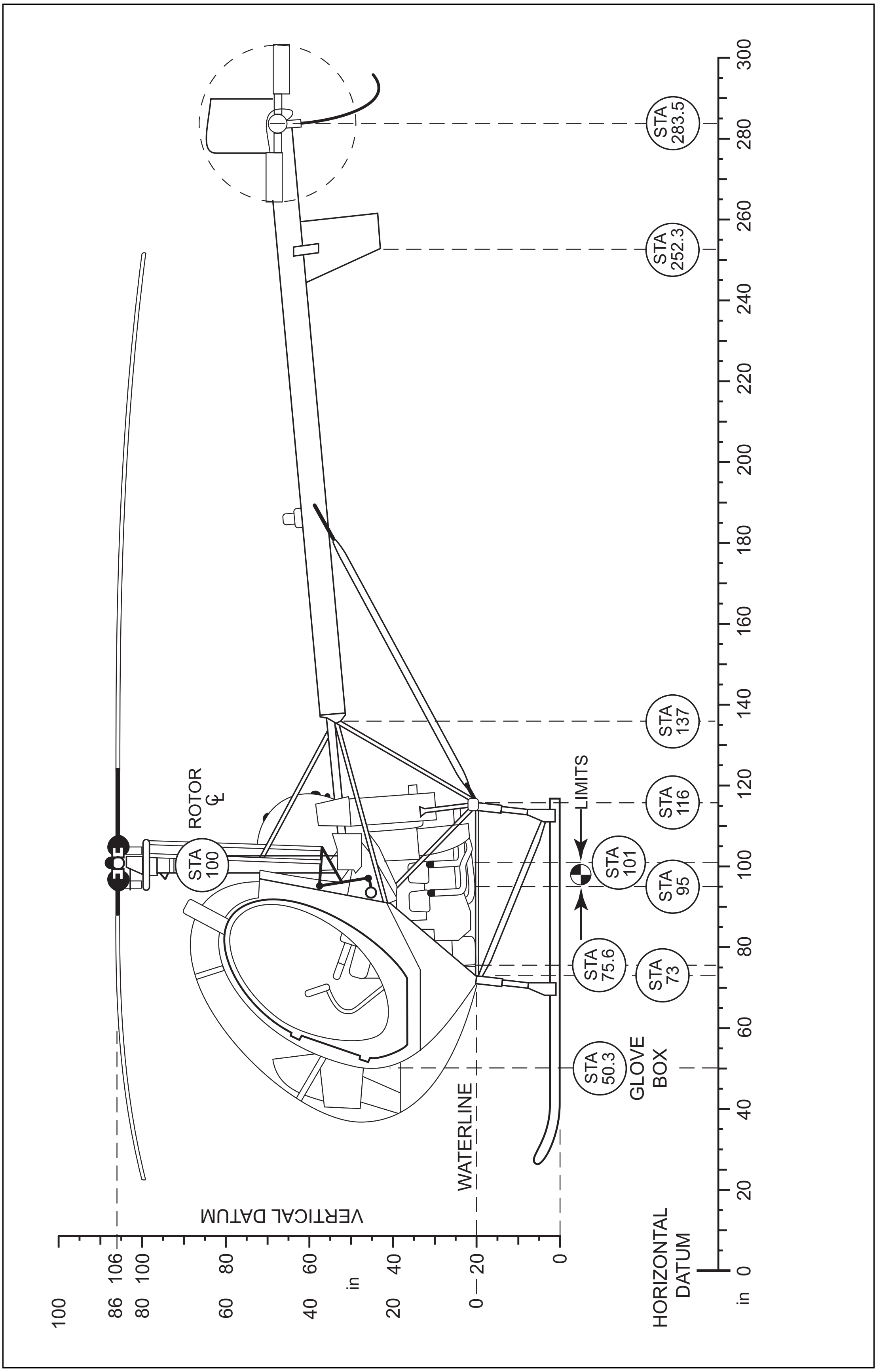


Figure 2.10 Station Diagram

4.5 **Balance Diagram (33-Gallon Standard Tank)**

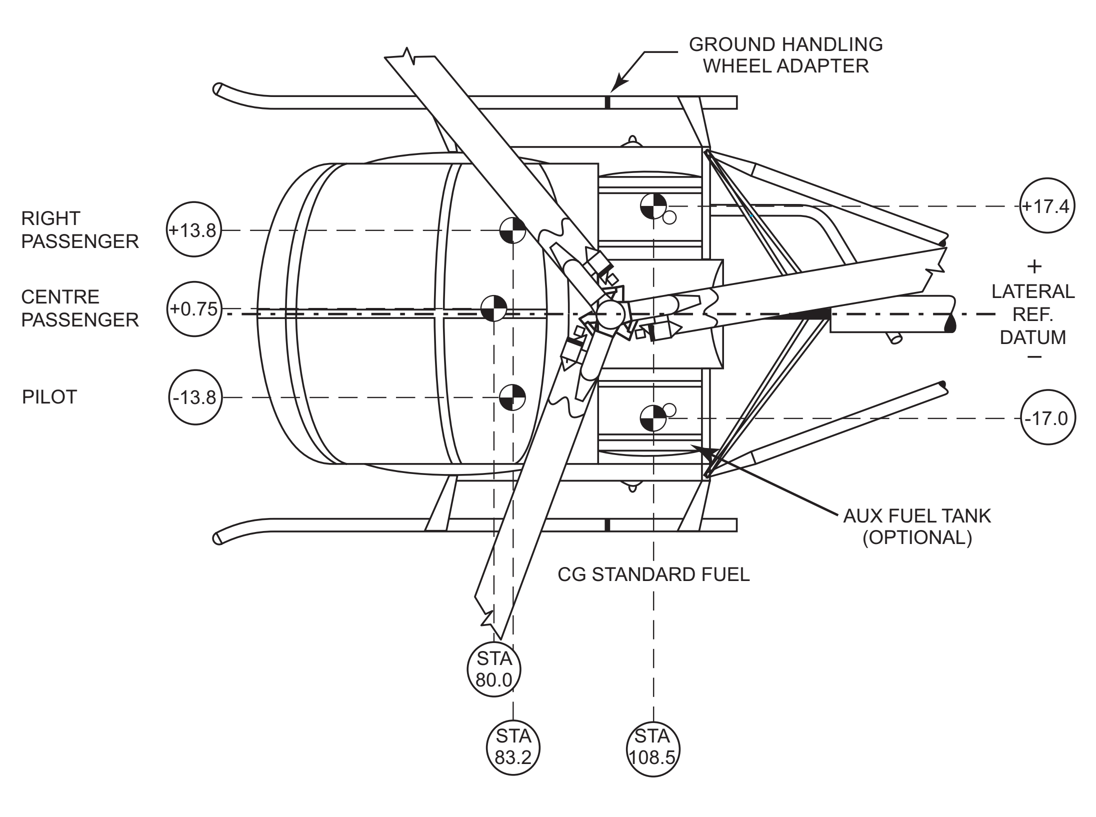


Figure 2.11 Balance Diagram (33-Gallon Standard Tank)

4.6 **Mass and Balance Records**

4.6.1 **Mass and Balance Schedule**

When a helicopter is weighed a Mass and Balance Schedule pro-forma must be completed for the Basic Empty Mass. Both the longitudinal and lateral moments must be calculated for each weighing point. From these details the longitudinal and lateral arm of the CG is established. An example is shown in Figure 2.12.

4.6.2 **Limiting Masses**

The details derived as in Figure 2.12 are used to calculate the CG balance arm for the Basic Empty Mass (plus any missing standard equipment), the Zero Fuel Mass and the Operating Mass. An example is shown in Figure 2.13.

4.6.3 **Record of Changes**

Any changes to the original Mass and Balance details as delivered by the manufacturer must be calculated and recorded. An example is shown in Figure 2.14.

4.7 Example Mass and Balance Schedule

HELICOPTER MODEL	SERIAL NUMBER	REGISTRATION NUMBER
DATE		WEIGHED BY

WEIGHING POINT	SCALE READING (LB)	TARE (LB)	NET WEIGHT (LB)	LONGIT. ARM (IN)	LATERAL ARM (IN)	LONGIT. MOMENT (LB IN)
LEFT MAIN	482	1.9	480	75.6	-19.0	36288
RIGHT MAIN	500	1.9	498	75.6	+19.0	37649
AFT	148	2.9	145	271.4	+0.6	39353
TOTAL (AS WEIGHED)	1130	6.7	1123	100.9	+0.4	113290

A DISTANCE FROM STATION 100.0 TO MAIN WEIGHING POINTS IN INCHES	RIGHT HAND 24.4	LEFT HAND 24.4
B AVERAGE MOMENT ARM FOR MAIN WEIGHING POINTS (100.0A)	100.0 - 24.4 = 75.6	
C MOMENT ARM FOR AFT WEIGHING POINT IN INCHES	271.4	

OIL ABOARD	[X] YES	[ ] NO
MAIN GEAR BOX	[X] YES	[ ] NO
TAIL GEAR BOX	[X] YES	[ ] NO
FULL FUEL ABOARD	[ ] YES	[X] NO

EQUIPMENT MISSING AT TIME OF WEIGHING

ITEM NUMBER	WEIGHT	LONGIT ARM	LATERAL ARM	LONG MOMENT	LATERAL MOMENT	
405 FLIGHT MANUAL	1.0	48.0	0	48	0	
UNUSEABLE FUEL (33 gal. fuel tank)	3.0	108.5	+17.4	325	+52	

NOTE: Removable portions of ground handling wheel installation (if so equipped) are ***NOT*** *included in aircraft empty weight*

TOTAL	4.0	93.3	+13	373	+52	

SURPLUS EQUIPMENT IN AIRCRAFT AT TIME OF WEIGHING

ITEM NUMBER	WEIGHT	LONGIT ARM	LATERAL ARM	LONG MOMENT	LATERAL MOMENT	
TOTAL						

Figure 2.12 Example Mass and Balance Schedule

4.8 Example Mass and Balance Worksheet for Limiting Masses

BASIC WEIGHT	WEIGHT (LB)	LONGIT ARM (IN)	MOMENT (LB IN)
WEIGHT (AS WEIGHED)	1123	100.9	113311
SURPLUS WEIGHT			
MISSING STANDARD EQUIPMENT	4.0	93.3	373
MISSING OPTIONAL EQUIPMENT			
TOTAL BASIC WEIGHT (DELIVERED)	1127	100.9	113684
LATERAL CENTRE OF GRAVITY ⟶ + 0.4			
MOST FORWARD LOADING	**WEIGHT (LB)**	**LONGIT ARM (IN)**	**MOMENT (LB IN)**
BASIC WEIGHT	1127	100.9	113714
PILOT AND PASSENGER R.H.	340	83.2	28288
USEABLE FUEL	0	108.5	0
PASSENGER, CENTRE	170	80.0	13600
TOTAL GROSS WEIGHT	1637	95.1	155602
APPROVED FORWARD LIMIT 95 INCHES ↑			
MOST AFT LOADING	**WEIGHT (LB)**	**LONGIT ARM (IN)**	**MOMENT (LB IN)**
BASIC WEIGHT	1127	100.9	113714
PILOT	170	83.2	14144
FUEL, FULL (32.5 USEABLE GAL.)	195	108.5	21158
TOTAL GROSS WEIGHT	1492	99.9	149016
APPROVED AFT LIMIT 101 INCHES ↑			

Figure 2.13 Example Mass and Balance Worksheet for Limiting Masses

4.9 Example Mass and Balance Record of Changes Pro-forma

BASIC WEIGHT AND BALANCE RECORD - LONGITUDINAL (LONG.) AND LATERAL (LAT.)
(CONTINUOUS HISTORY OF CHANGES IN STRUCTURE OR EQUIPMENT AFFECTING WEIGHT AND BALANCE)

AIRCRAFT MODEL | SERIAL NUMBER | REGISTRATION NUMBER | PAGE | OF

	ITEM NO.			LONGITUDINAL			LATERAL		RUNNING TOTAL - EMPTY AIRCRAFT				
									WEIGHT	LONGITUDINAL		LATERAL	
											MOMENT		MOMENT
DATE	IN	OUT	DESCRIPTION OF ARTICLE OR MODIFICATION	WEIGHT +ADD -REMOVE	ARM	MOMENT	ARM + RIGHT - LEFT	MOMENT		ARM	LB IN	ARM	LB IN
			TOTAL DELIVERED MASS						1127	100.9	113714	+0.4	+451
1/24/94			REMOVE 7 LBS. ITEM AT STA. 103, LBL12	-7	103	-721	-12	+84	1120	100.9	113008	+0.5	+560
1/27/94			ADD 11 LBS. ITEM AT STA. 74, RBL 6	+11	74	+814	+6	+66	1131	100.6	113779	+0.5	+566

Figure 2.14 Example Mass and Balance Record of Changes Pro-forma

4.10 **Load Limits and Balance Criteria**

NOTE: Do not exceed limitations at any time during flight.

- The delivered mass (the term 'delivered mass' includes oil and trapped fuel), recorded in the Mass and Balance Record of Changes pro-forma (as shown in Figure 2.14), shall be used to perform all mass and balance computations (see Figures 2.12 and 2.13).

4.11 **Equipment Removal or Installation**

- Removal or addition of equipment must be entered in the helicopter log book and shall become part of the helicopter file.
- The mass and balance effects of these changes must also be recorded in the Mass and Balance Record of Changes pro-forma, as shown in Figure 2.14.
- Use the Station Diagram shown in Figure 2.10 and the Balance Diagram shown in Figure 2.11 as an aid for mass and balance changes.

4.12 **Mass and Balance Calculation – Passenger Configuration**

- To determine that the gross mass and longitudinal CG (fore and aft) for a given flight are within limits, proceed as follows:
    - Obtain the helicopter delivered mass and longitudinal moment from the Mass and Balance Record of Changes pro-forma found at the end of the Pilot's Flight Manual (see Figure 2.14 for an example).
    - Determine mass and longitudinal moments of useful load items from Figure 2.17.
    - Add the above items (see Example 1 below).
    - Plot on Figure 2.9 together with associated lateral CG.

4.13 **Example 1 – Longitudinal CG**

Items	Mass (lb)	Longitudinal Arm (in)	Longitudinal Moment (lb in)
Delivered Mass	+1,127	+100.9	+113,714
Pilot - Left-Hand Passenger - Right-Hand Passenger - Centre	+170 +170 +170	+83.2 +83.2 +80.0	+14,144 +14,144 +13,600
1. Sub-Total Gross Mass (Zero Fuel Mass) Fuel	+1,637 +195	+95.1 +108.5	+155,602 +21,158
2. Total Gross Mass	+1,832	+96.5	+176,760

- Calculation of Longitudinal CG
  - CG Zero Fuel Mass:

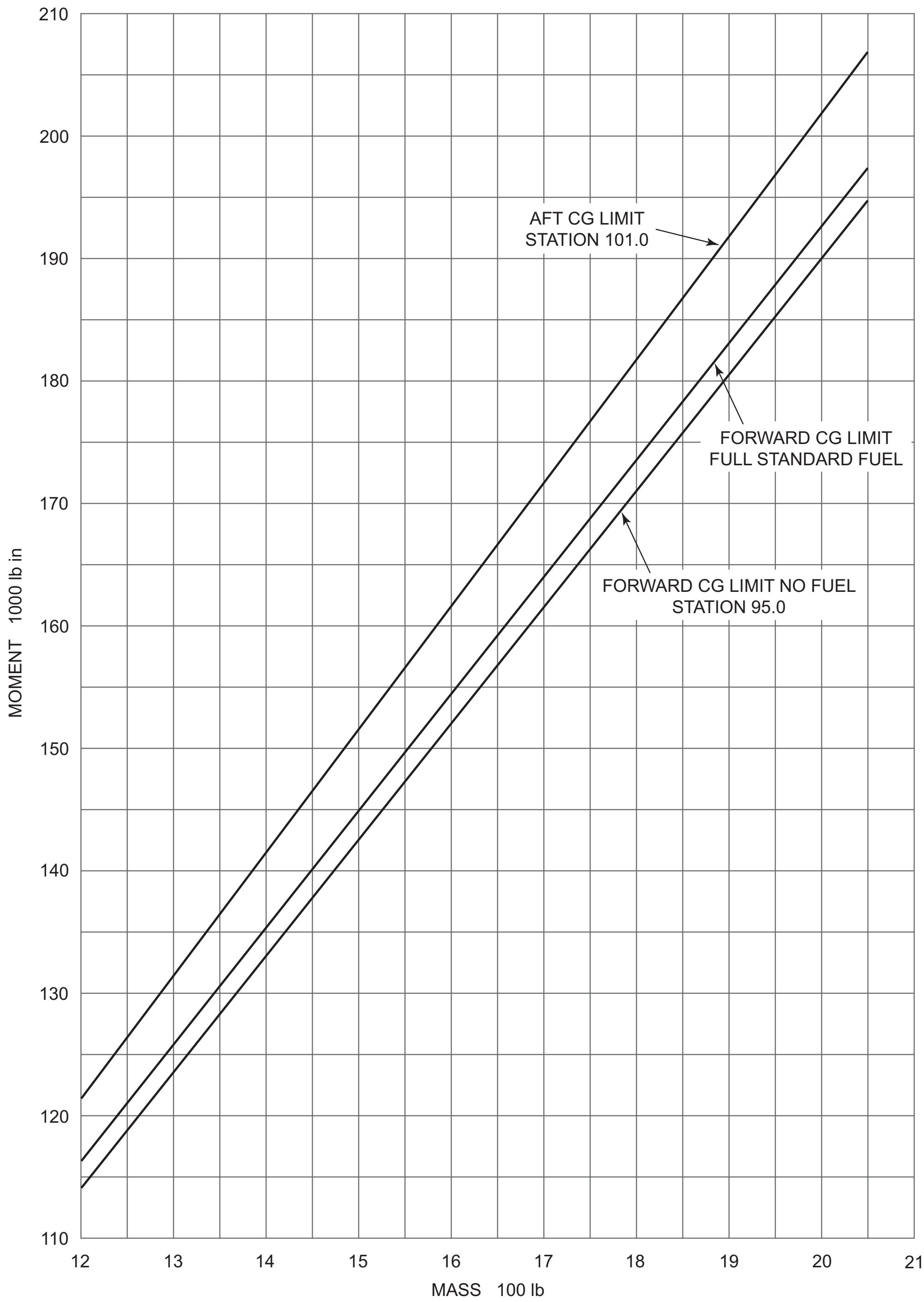
$$\frac{\text{Moment at Zero Fuel Mass}}{\text{Zero Fuel Mass}} = \frac{155{,}602}{1{,}637} = 95.1 \text{ in}$$

  - CG Total Gross Mass:

$$\frac{\text{Moment at Gross Mass}}{\text{Gross Mass}} = \frac{176{,}760}{1{,}832} = 96.5 \text{ in}$$

NOTE: The CGs fall within the limits specified in Figure 2.15. Therefore, the loading meets the longitudinal CG requirements, for full fuel as well as zero fuel.

4.14 Mass and Moment Loading Chart – Longitudinal Limitations



NOTE: This chart applies the longitudinal centre of gravity limits noted. CG limit changes or restrictions resulting from special kit installations require that CGs be determined by dividing total moment by total mass for both zero and full fuel conditions.

Figure 2.15 Mass and Moment Loading Chart – Longitudinal Limitations

4.15 **Permissible Lateral Loadings – Passenger Configuration**

For the safe operation of the helicopter, it must be flown within the established lateral, as well as longitudinal, CG limits.

NOTE: Lateral CG must be controlled.

- All combinations of passenger loadings are permissible if gross mass, longitudinal, and lateral CG considerations permit.
- To determine that the gross mass and lateral CG (left and right) are within limits for a given flight, proceed as follows:
  - Obtain the helicopter delivered mass and moment from the Mass and Balance Record of Changes pro-forma found at the end of the Pilot's Flight Manual (see Figure 2.14 for an example).
  - Determine the mass and lateral moment for various configurations (see Figure 2.16).
  - Add the above items (see Example 2 below).
  - Plot on Figure 2.9 with associated longitudinal CG.

4.16 **Example 2 – Lateral CG**

Items	Mass (lb)	Lateral Arm (in)	Lateral Moment (lb in)
Delivered Mass	+1,127	+0.43	+485
Pilot - Left-Hand Passenger - Right-Hand Passenger - Centre	+170 +170 +170	-13.8 +13.8 +0.75	-2,346 +2,346 +128
1. Sub-Total Gross Mass (Zero Fuel Mass) Fuel	+1,637 +195	+0.37 +17.4	+613 +3,393
2. Total Gross Mass	+1,832	+2.19	+4,006

- Calculation of Lateral CG
  - CG Zero Fuel Mass:

$$\frac{\text{Moment at Zero Fuel Mass}}{\text{Zero Fuel Mass}} = \frac{+613}{1{,}637} = +0.37 \text{ in}$$

  - CG Total Gross Mass:

$$\frac{\text{Moment at Gross Mass}}{\text{Gross Mass}} = \frac{+4{,}006}{1{,}832} = 2.19 \text{ in}$$

NOTE: The determined lateral CGs of +0.37 in and +2.19 in for longitudinal CGs of 95.1 in and 96.5 in, respectively, fall within the established CG limits. (See Figure 2.9 and Example 1 – Longitudinal CG.)

4.17 Lateral Mass-to-Moment Calculation Chart

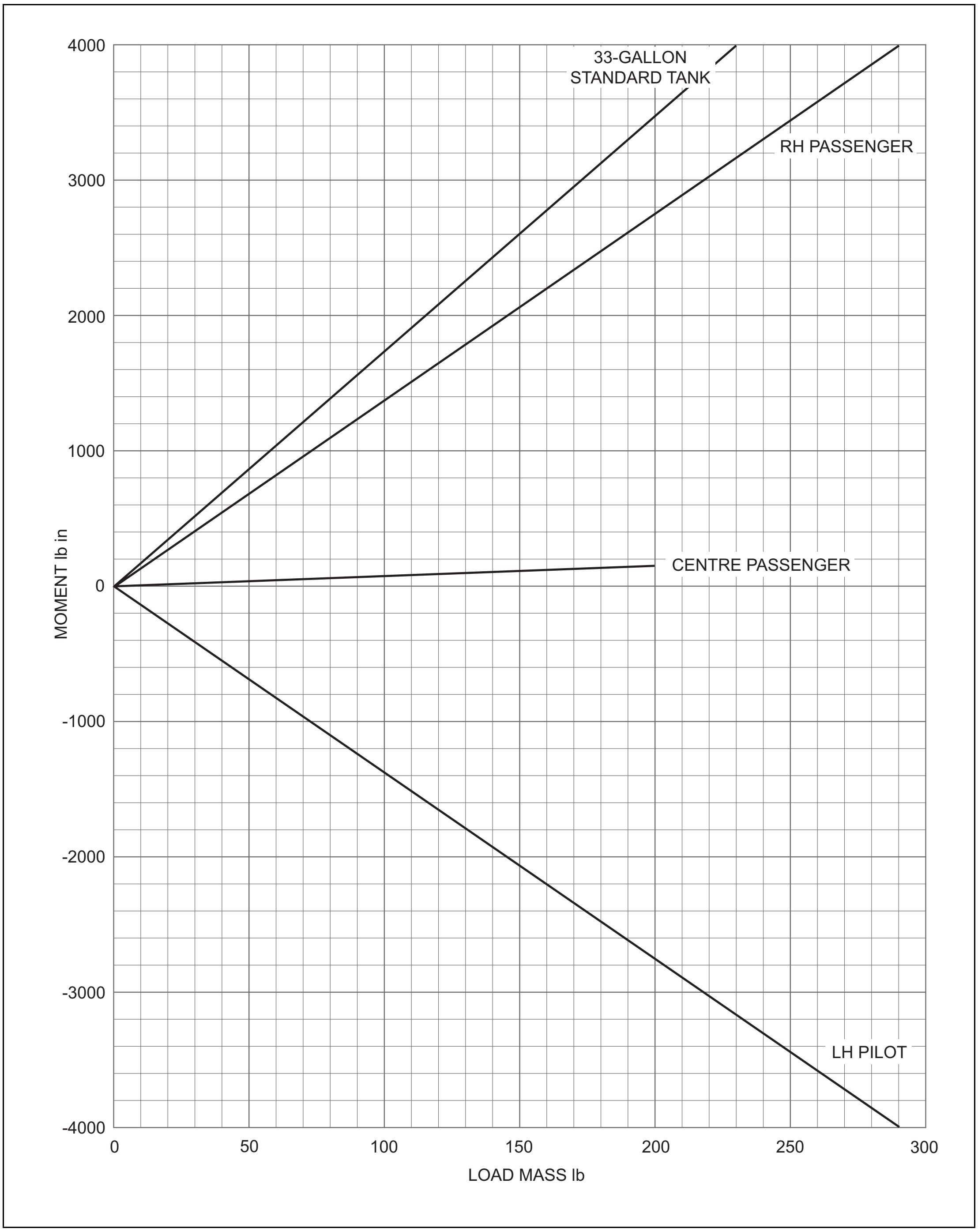


Figure 2.16 Lateral Mass-to-Moment Calculation Chart

4.18 Longitudinal Mass-to-Moment Calculation Chart

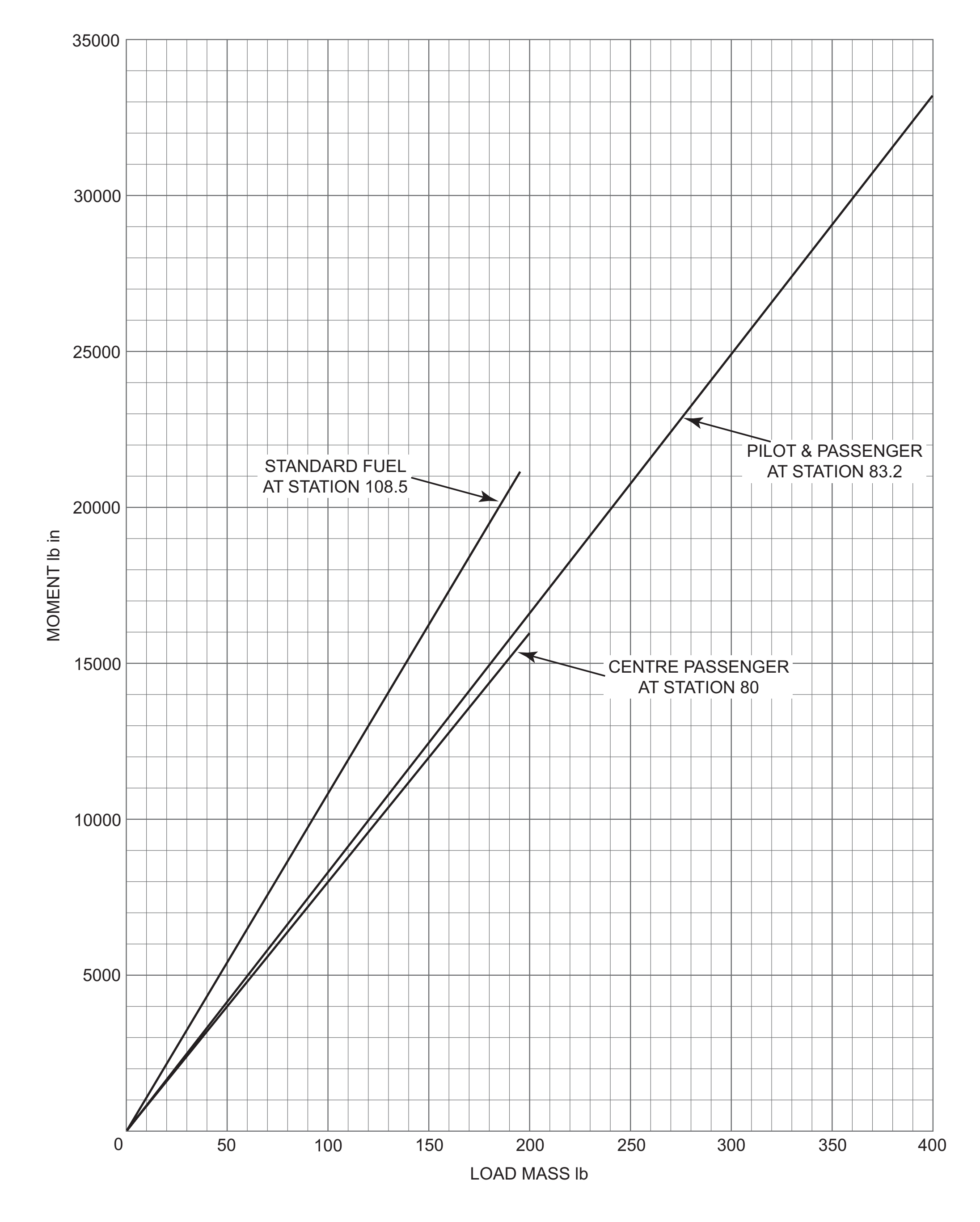


Figure 2.17 Longitudinal Mass-to-Moment Calculation Chart

5 Additional Operations and Performance Data

The information given in paragraph 5 is provided by the manufacturer to further inform the pilot of the helicopter's capabilities. By use of the data in paragraph 5 the pilot may obtain maximum utilisation of the helicopter.

5.1 Hover Ceiling v. Gross Mass (3,200 rpm) OGE

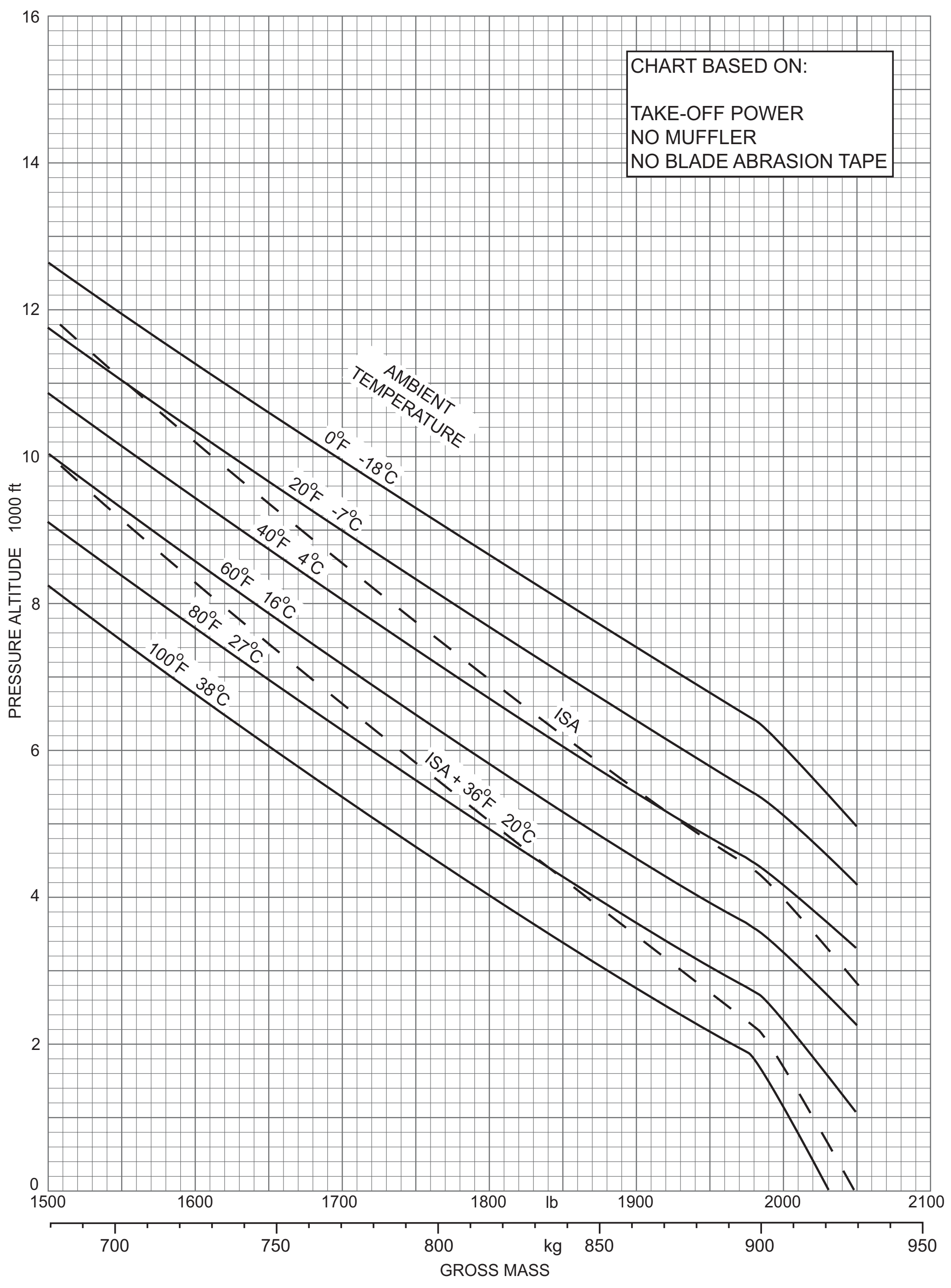


Figure 2.18 Hover Ceiling v. Gross Mass (3,200 rpm) out of Ground Effect

5.2 Rate-of-Climb Chart

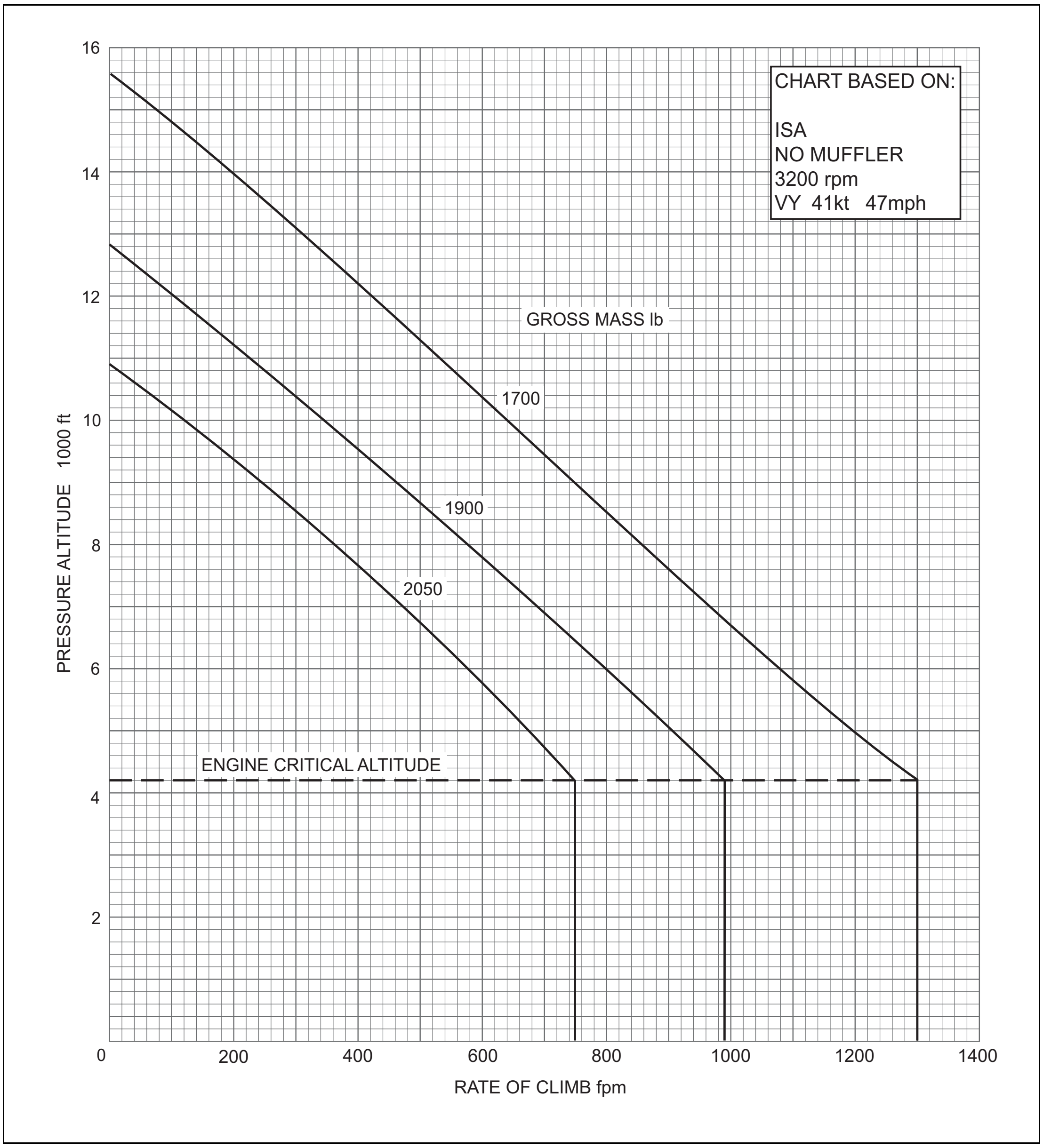


Figure 2.19 Rate-of-Climb Chart

5.3 Fuel Flow

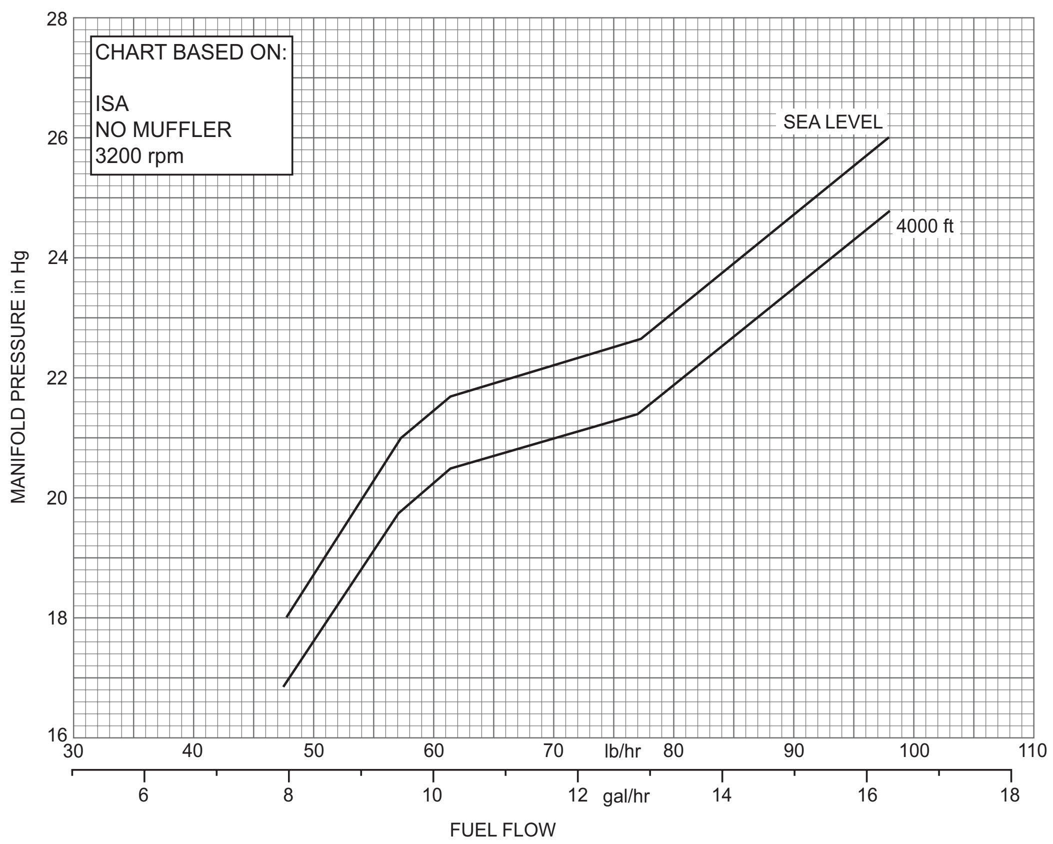


Figure 2.20 Fuel Flow

5.4 Maximum Cruise Speed

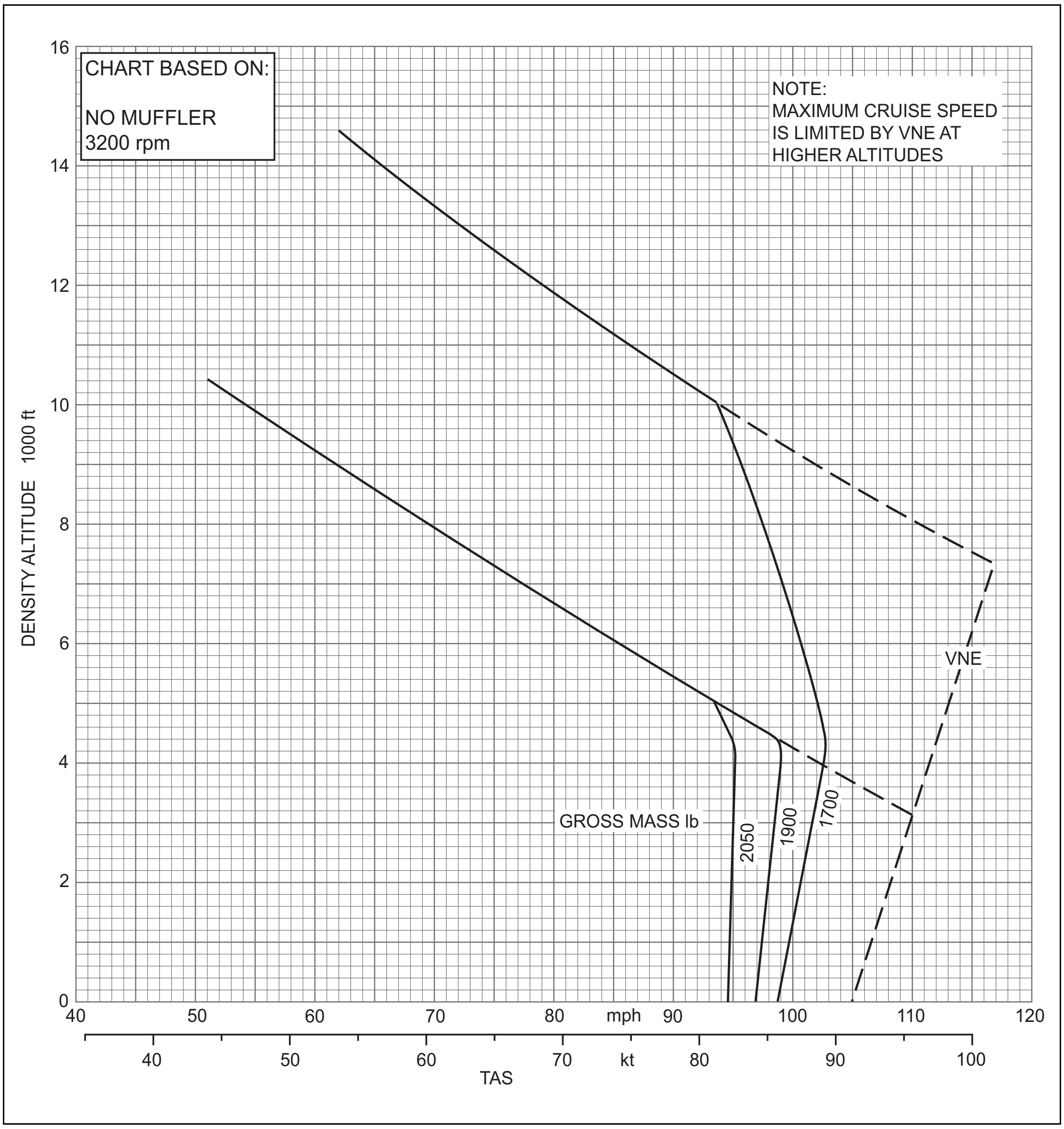


Figure 2.21 Maximum Cruise Speed

5.5 Cruise Chart (Sea Level)

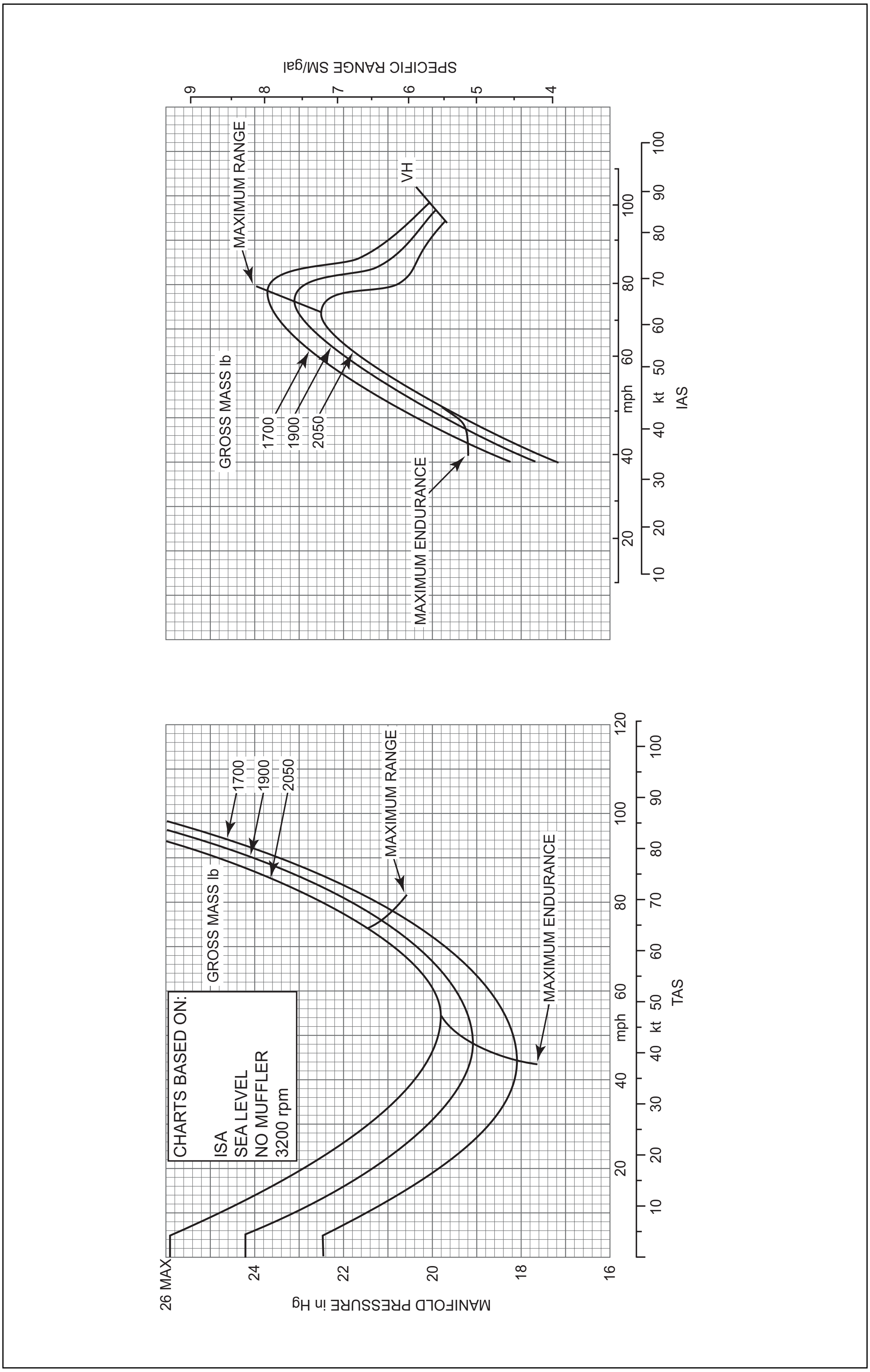


Figure 2.22 Cruise Chart (Sea Level)

5.6 Cruise Chart (4,000 ft)

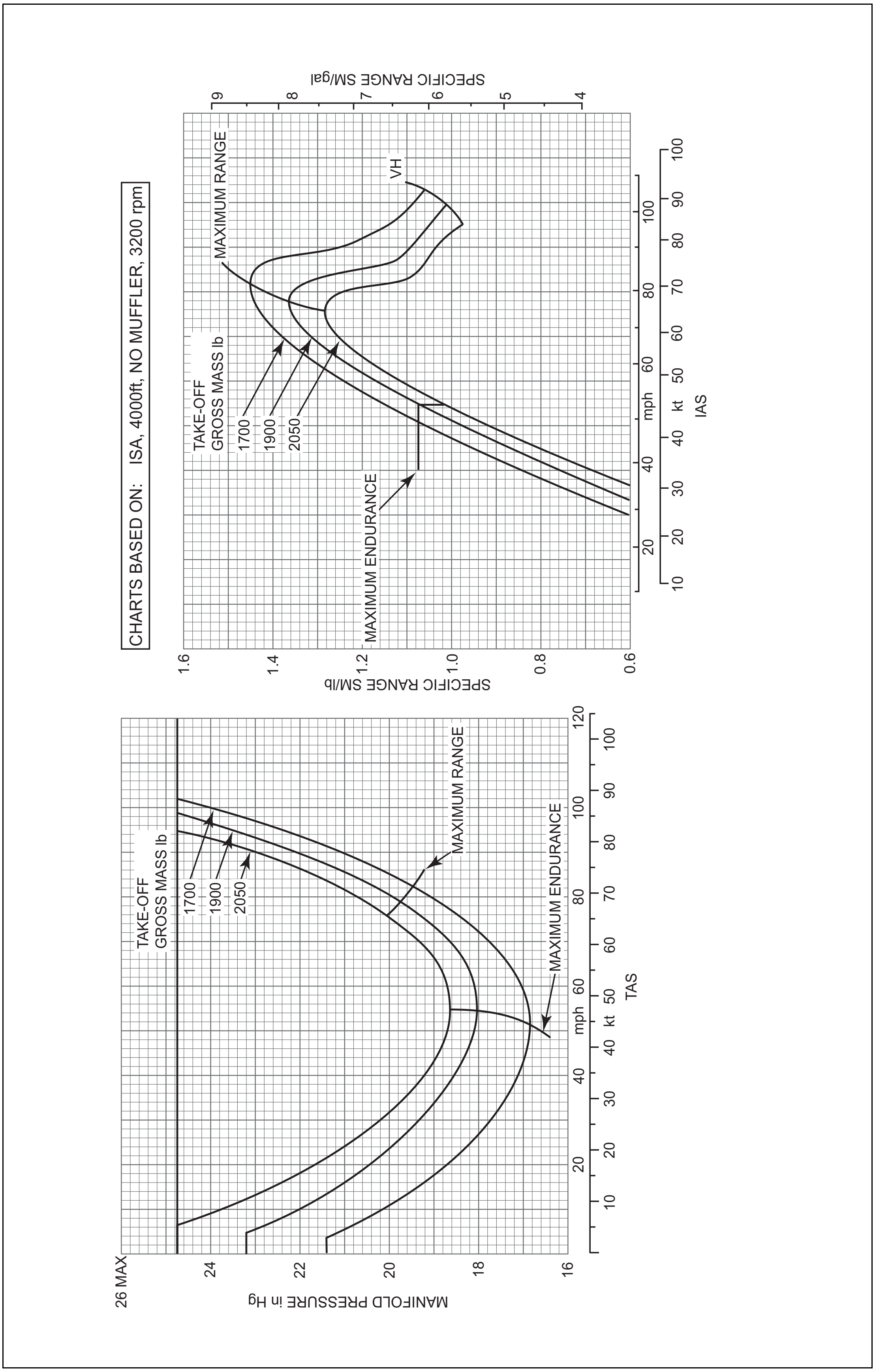


Figure 2.23 Cruise Chart (4,000 ft)

5.7 Sea-Level Range and Endurance (Standard Day, 3,200 Engine rpm, No Muffler)

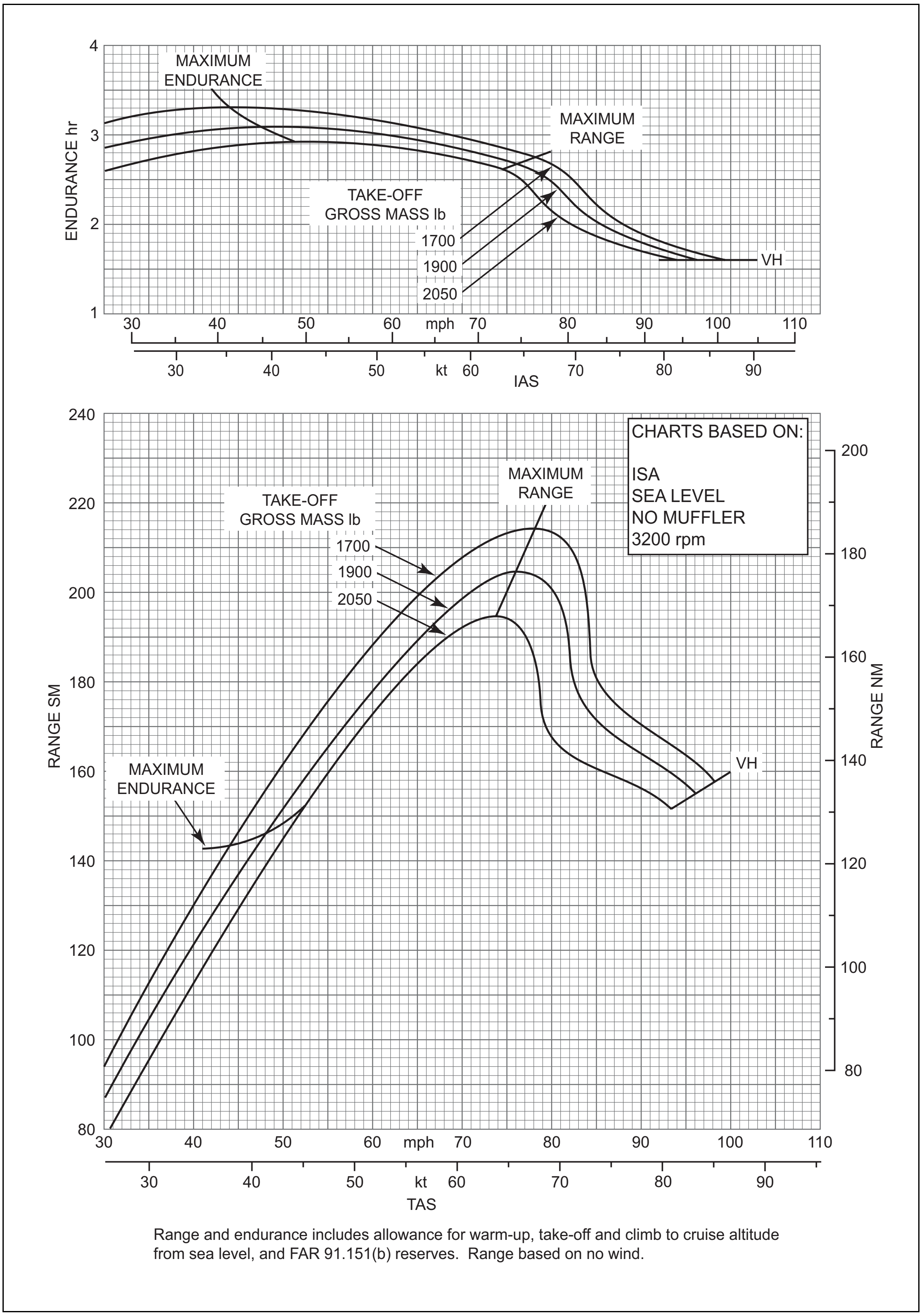


Figure 2.24 Sea-Level Range and Endurance (Standard Day, 3,200 Engine rpm, No Muffler)

5.8 4,000 ft Range and Endurance (Standard Day, 3,200 Engine rpm, No Muffler)

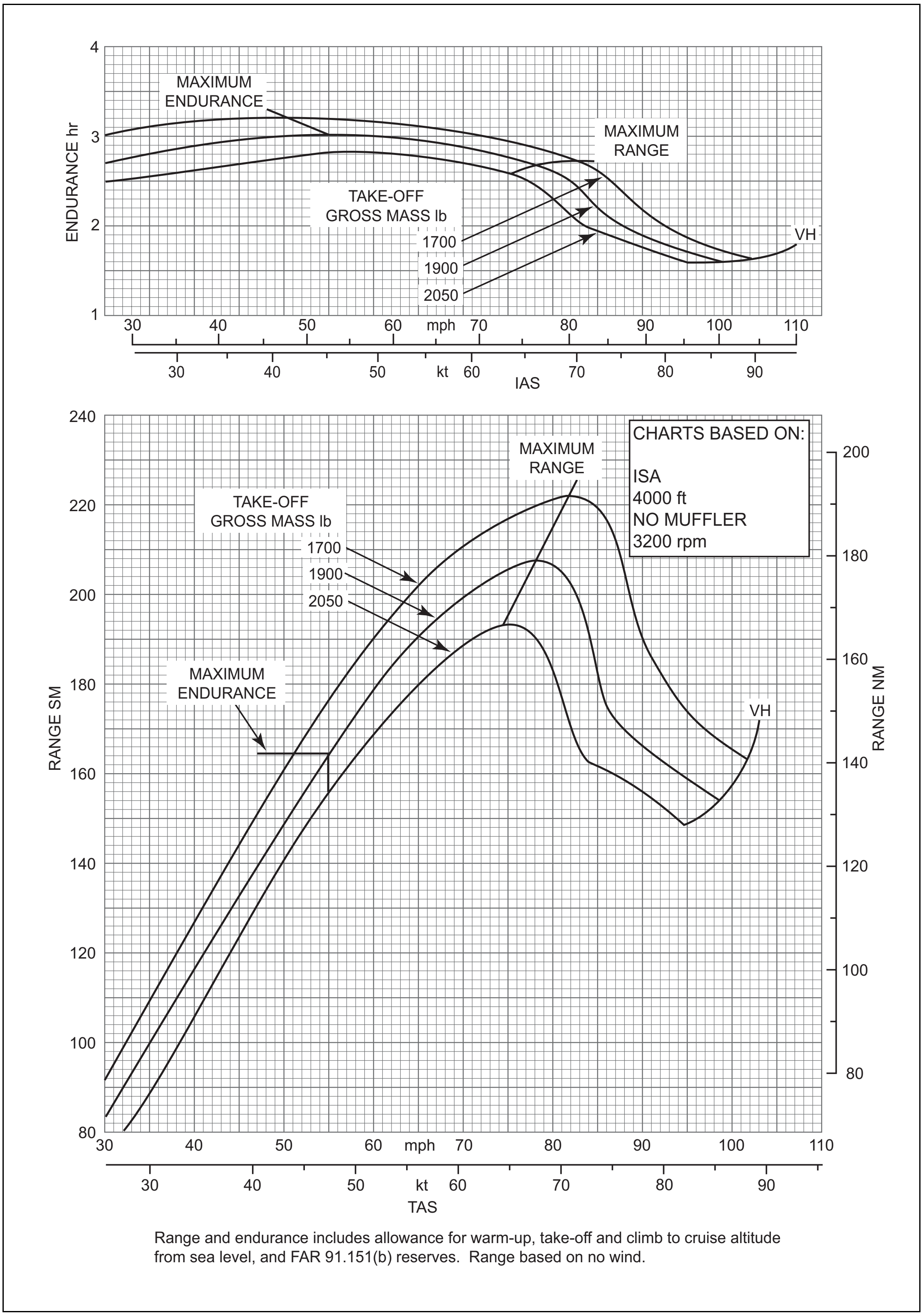
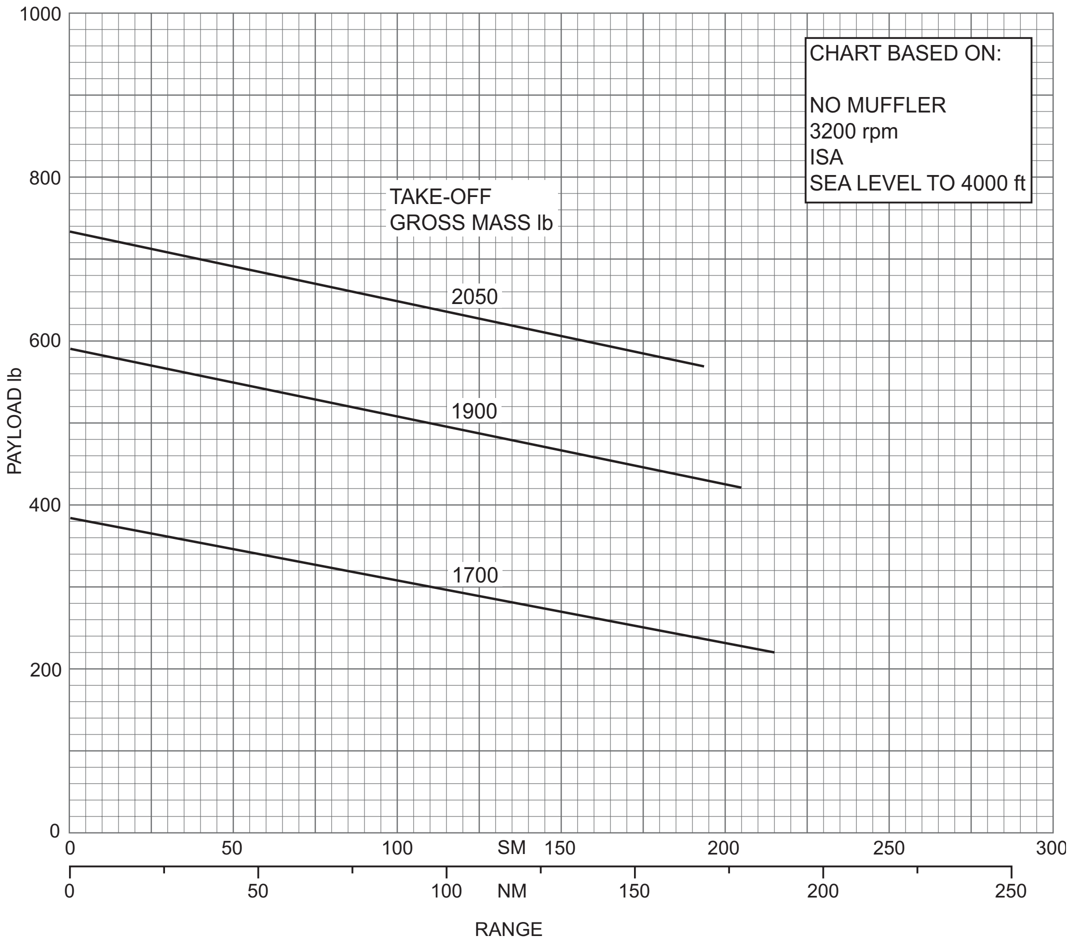


Figure 2.25 4,000 ft Range and Endurance (Standard Day, 3,200 Engine rpm, No Muffler)

5.9 Payload v. Range



This chart shows the range trend that results from trading off fuel against payload, while keeping a constant gross mass. Maximum range for each gross mass includes a full fuel load at take-off. Range includes allowance for warmup, take-off and climb to cruise altitude from sea level with reserves. Range is based on no wind and cruise at maximum range speed.

Figure 2.26 Payload v. Range

5.10 Rate-of-Descent Chart

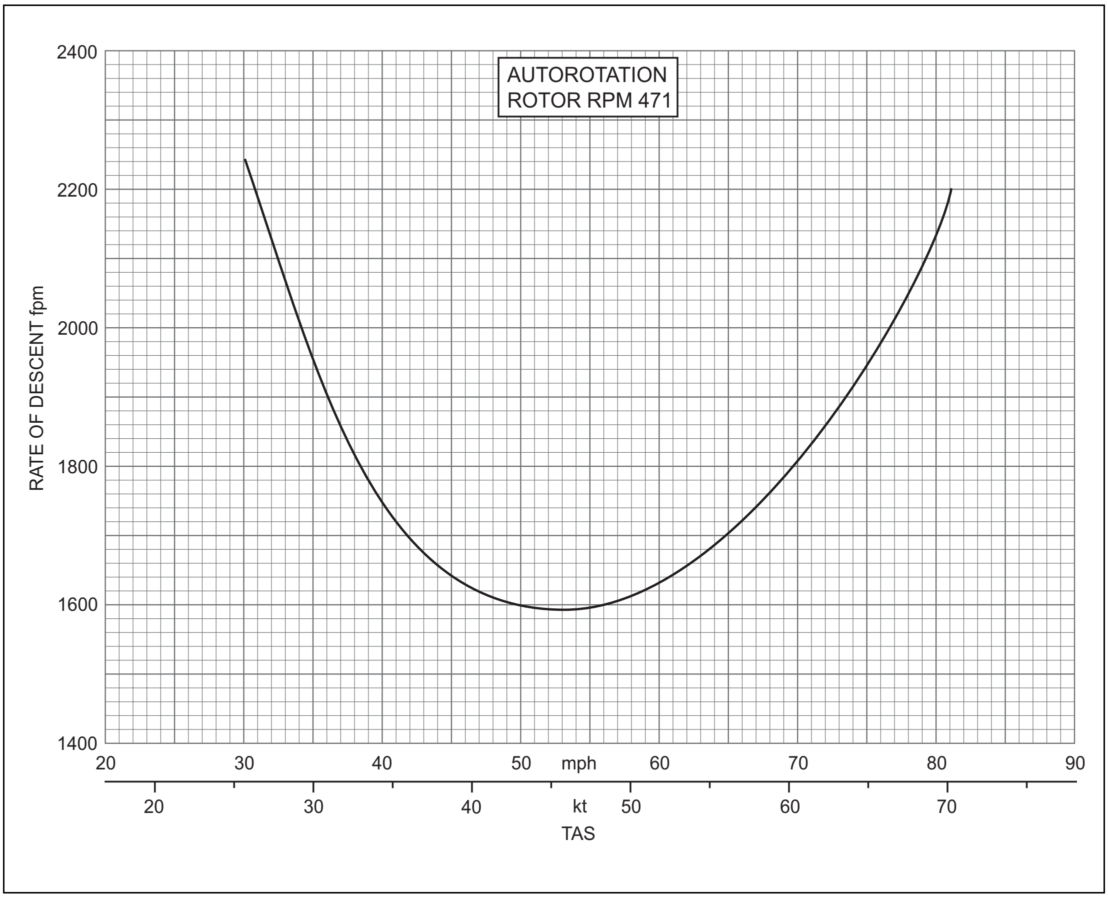


Figure 2.27 Rate-of-Descent Chart

Section 3 Pilot's Flight Manual – TETH

1 General

1.1 TETH – Principal Dimensions

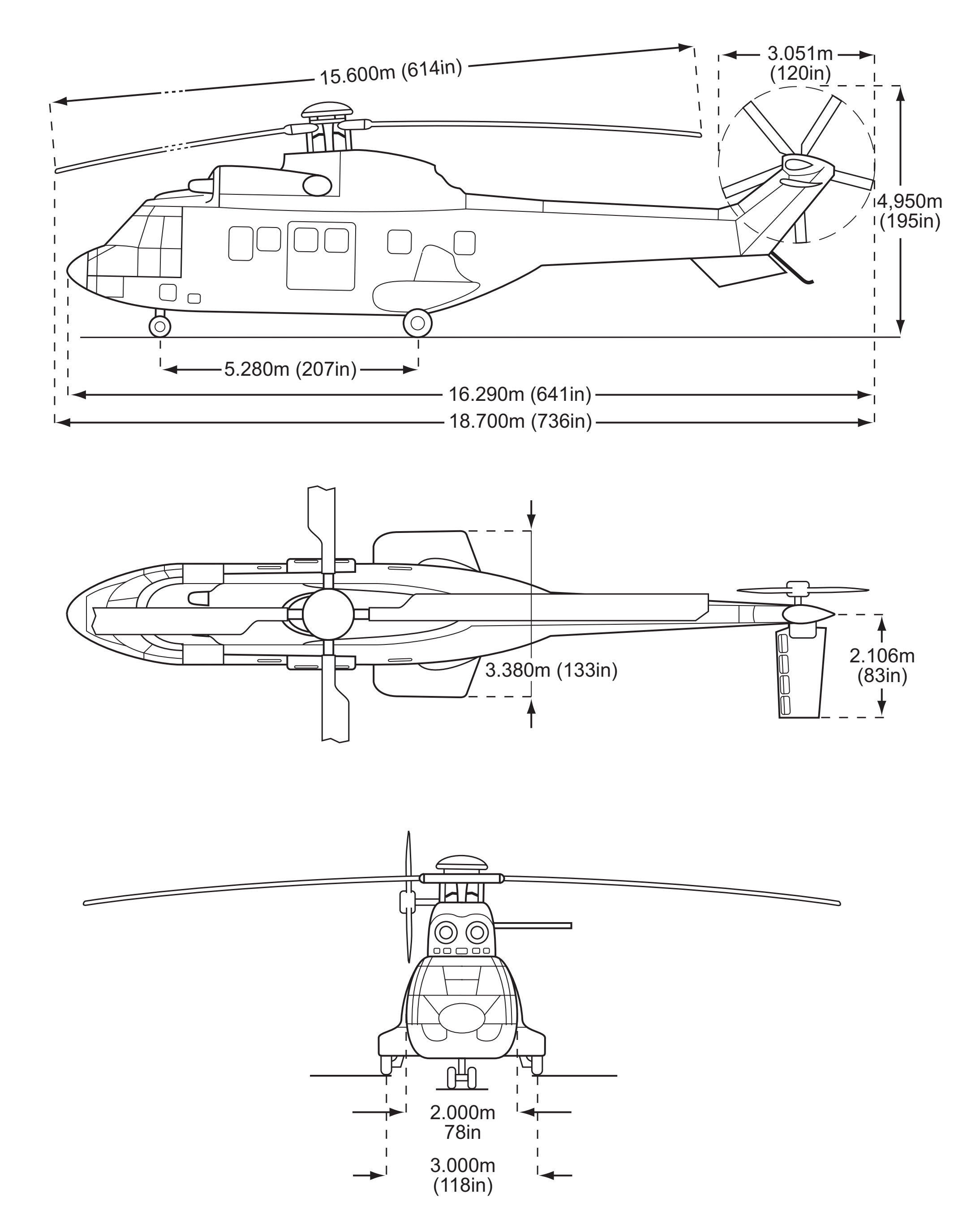


Figure 3.1 TETH – Principal Dimensions

2 Limitations

2.1 Mass Limits

The maximum permissible mass at take-off and landing with internal loads is 8,600 kg (18,960 lb). Depending on density altitude the maximum permissible take-off or landing mass is determined from Figure 3.2 below.

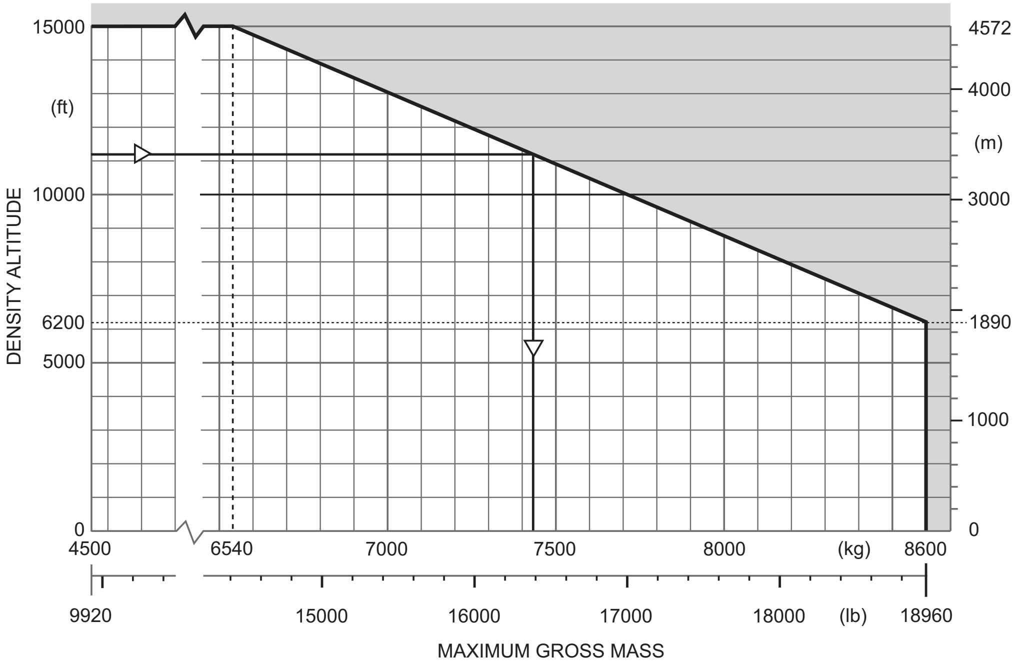


Figure 3.2 Mass Limitations for Take-Off and Landing with Internal Loads

The minimum permissible mass at any time is 4,500 kg (9,920 lb).

2.2 CG Limits

2.2.1 Longitudinal CG

For fore-and-aft longitudinal CG limits, refer to Figure 3.3 below.

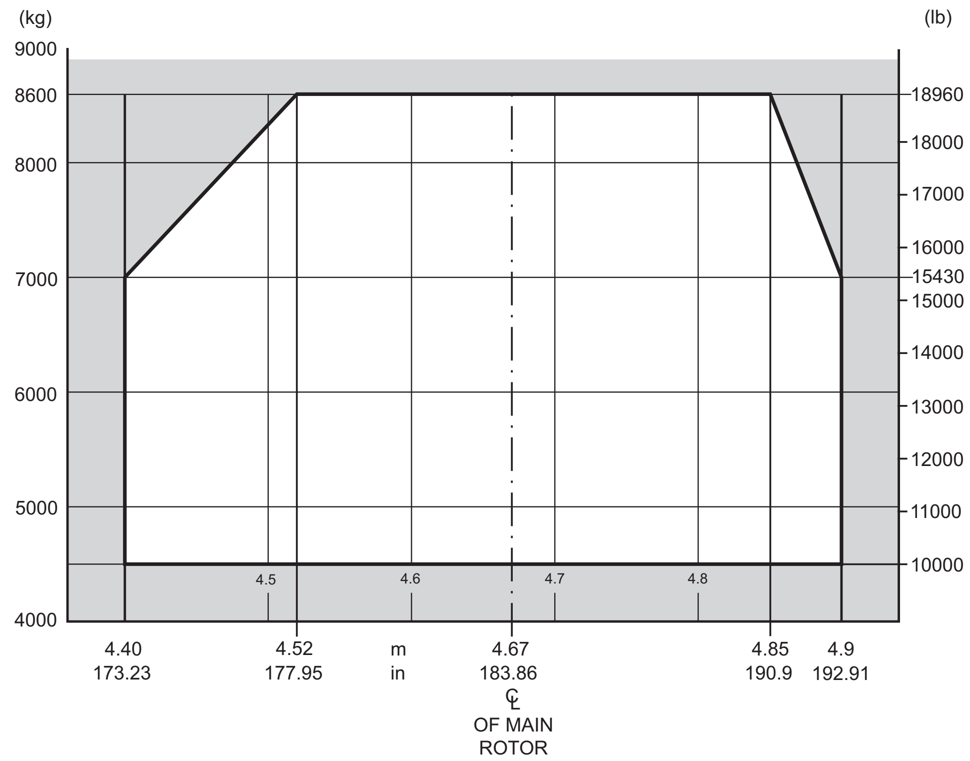


Figure 3.3 Longitudinal CG Limits

CAUTION: ALLOW FOR CG LOCATION VARIATIONS DUE TO FUEL CONSUMPTION AND FUEL TRANSFER (SEE FIGURE 3.23).

The CG datum is located 4.67 m (183.86 in) forward of the main rotor centreline.

2.2.2 Lateral CG Position

- LH limit: 0.08 m (3.15 in)

- RH limit: 0.09 m (3.54 in)

The CG datum is the helicopter symmetry plane.

2.3 Airspeed Limits

2.3.1 Absolute V_{NE}: Power-On Flight

- For masses up to 8,350 kg (18,410 lb): 167 kt (310 km/h)
- For masses over 8,350 kg (18,410 lb): 150 kt (278 km/h)

2.3.2 Absolute V_{NE}: Power-Off Flight

Absolute V_{NE}: 145 kt (268 km/h)

Refer to Figure 3.4 for V_{NE} variations according to helicopter mass and altitude.

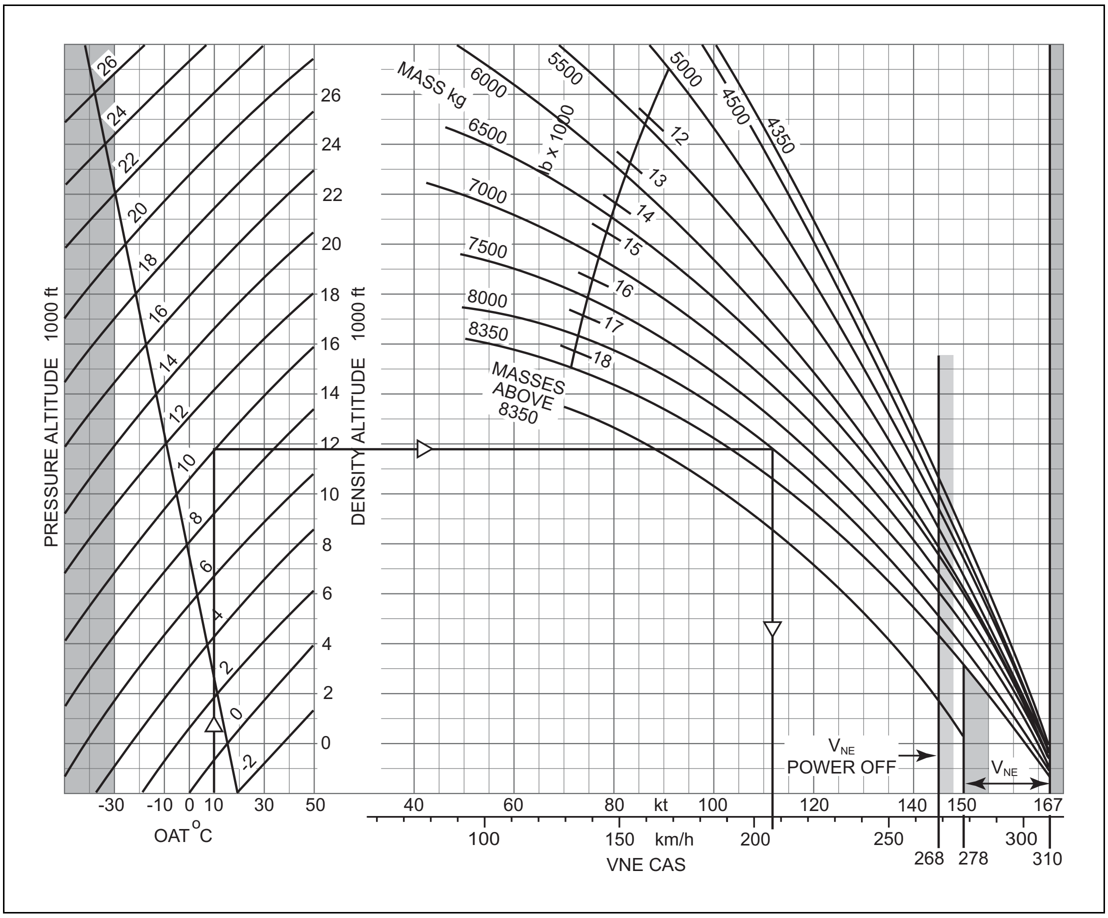


Figure 3.4 VNE Chart (Altitudes ft)

2.4 **Airspeed-Height Envelope (See Figure 3.5)**

The airspeed-height envelope depends on the helicopter mass and on exterior conditions.

Figure 3.5, Graph 1 shows the airspeed-height envelope for a helicopter weighing 8,350 kg (18,410 lb) at zero pressure altitude and 15°C OAT.

Points B and C are valid for all mass, altitude and temperature conditions. Point A must be determined from Figure 3.5, Graph 2 according to the mass, altitude and temperature conditions.

Under mass, altitude and temperature combinations for which Point A would be below 100 ft, the airspeed-height envelope is nil.

Example (see Figure 3.5, Graph 2)

Mass = 7,000 kg
Pressure Altitude = 0
OAT = +40°C

Solution

Height of Point A = 130 ft

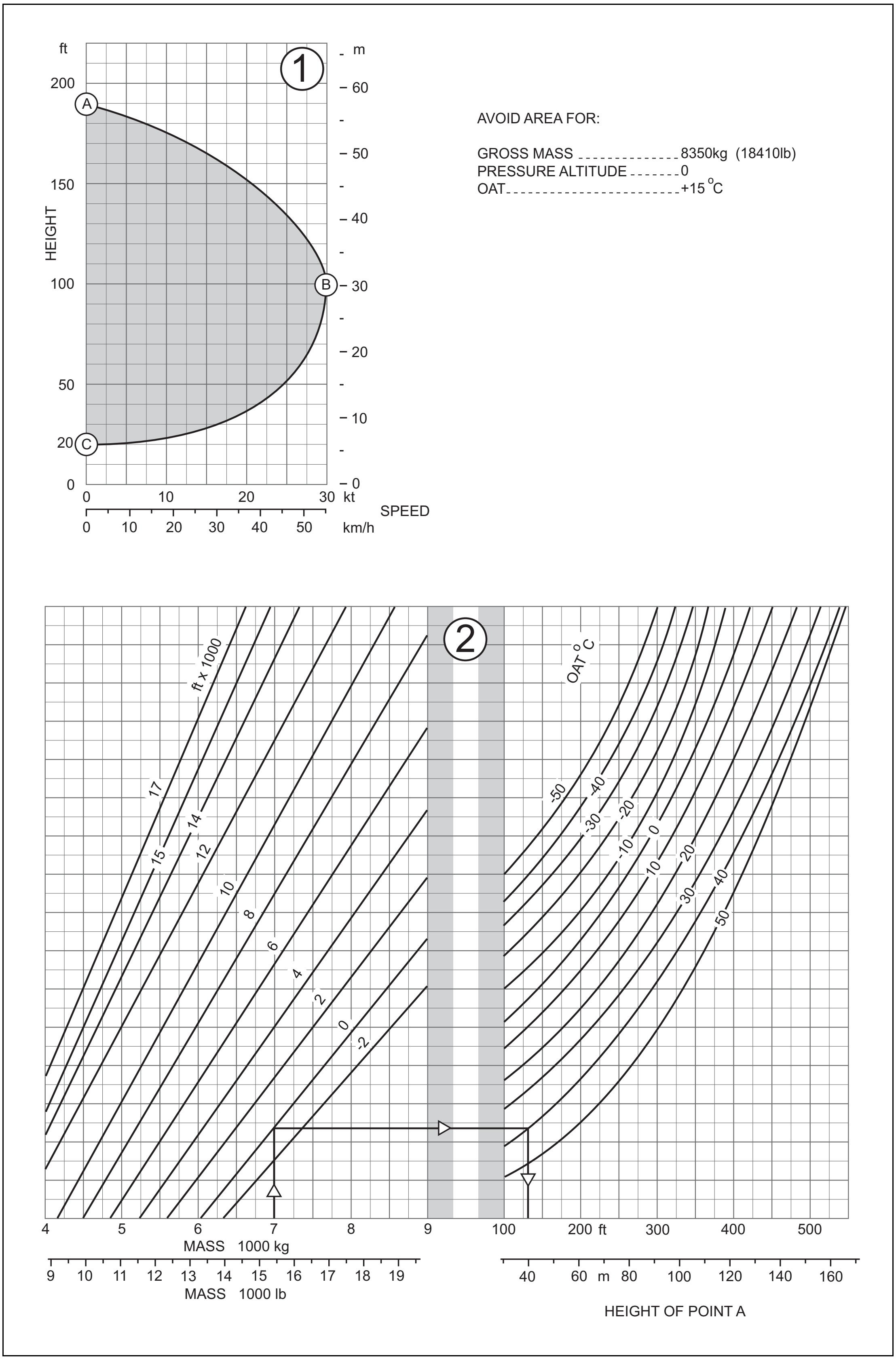


Figure 3.5 Airspeed-Height Envelope

2.5 Maximum Permissible Loading

2.5.1 Placards

Cabin floor:

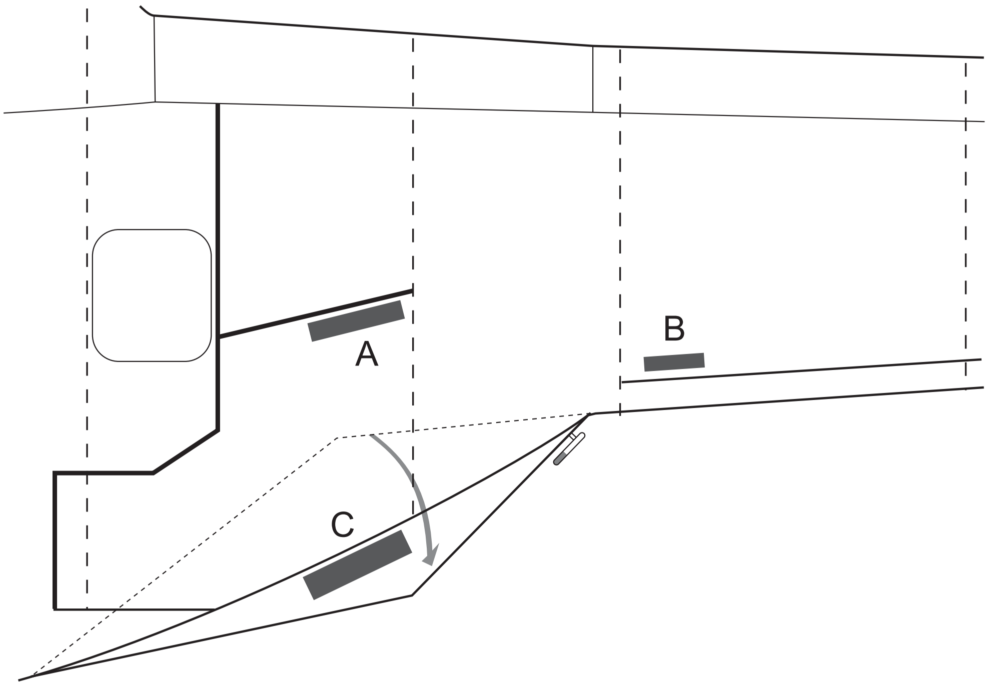
A placard in the cabin specifies the maximum load-carrying capacity.

CABIN FLOOR

LOADING 1500 daN/m^2
2.17 lbf/in^2

Cargo bay:

Three placards specify the maximum permissible load-carrying capacities.



A	LUGGAGE MAX LOAD MAXIMUM FLOOR LOAD	115 daN 195 daN/m^2
B	LUGGAGE MAX LOAD MAXIMUM FLOOR LOAD	55 daN 75 daN/m^2
C	LUGGAGE MAX LOAD MAXIMUM FLOOR LOAD	250 daN 400 daN/m^2

Figure 3.6 Luggage Floor Loads

3 Performance

3.1 Regulatory Performance Data

3.1.1 Introduction

The performance curves given hereafter, Figure 3.7 to Figure 3.17 inclusive, apply to the basic helicopter version (zone not shaded on the charts).

The broken-line curves enable helicopter operation below -30°C. The shaded zone enables helicopter operation with optional equipment.

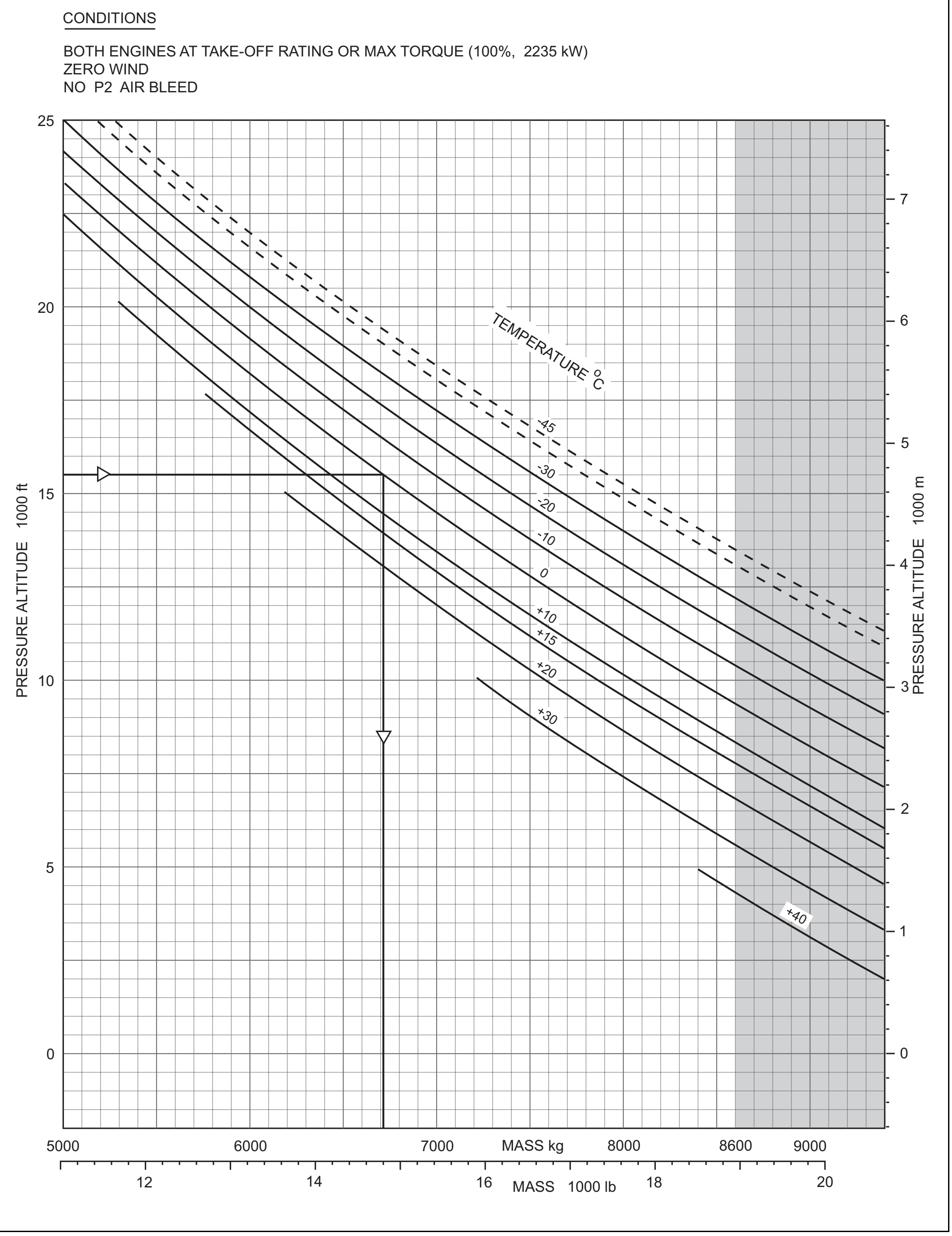


Figure 3.7 IGE Hover Performance – Two Engines (Height up to 15 ft)

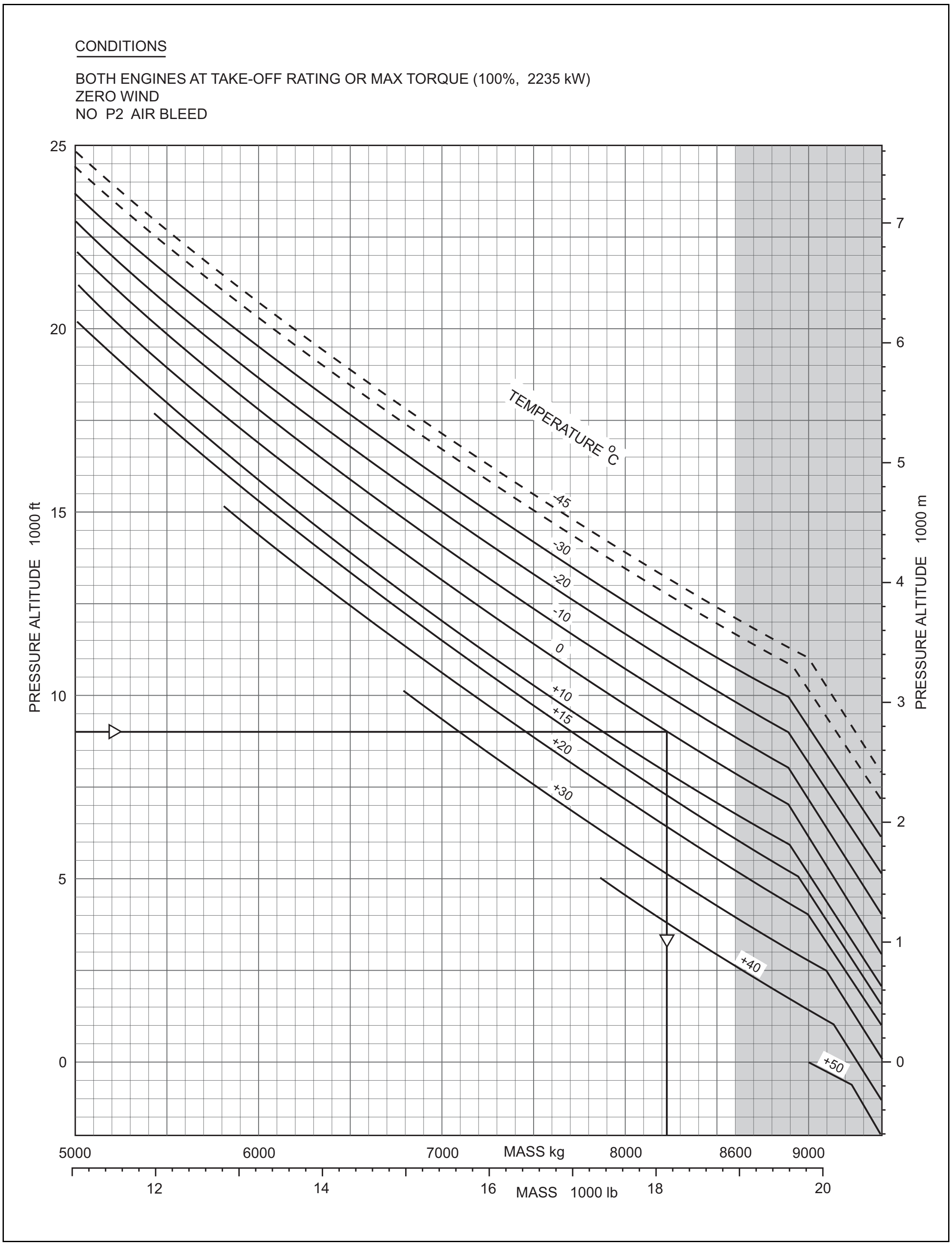


Figure 3.8 OGE Hover Performance – Two Engines (above 15 ft)

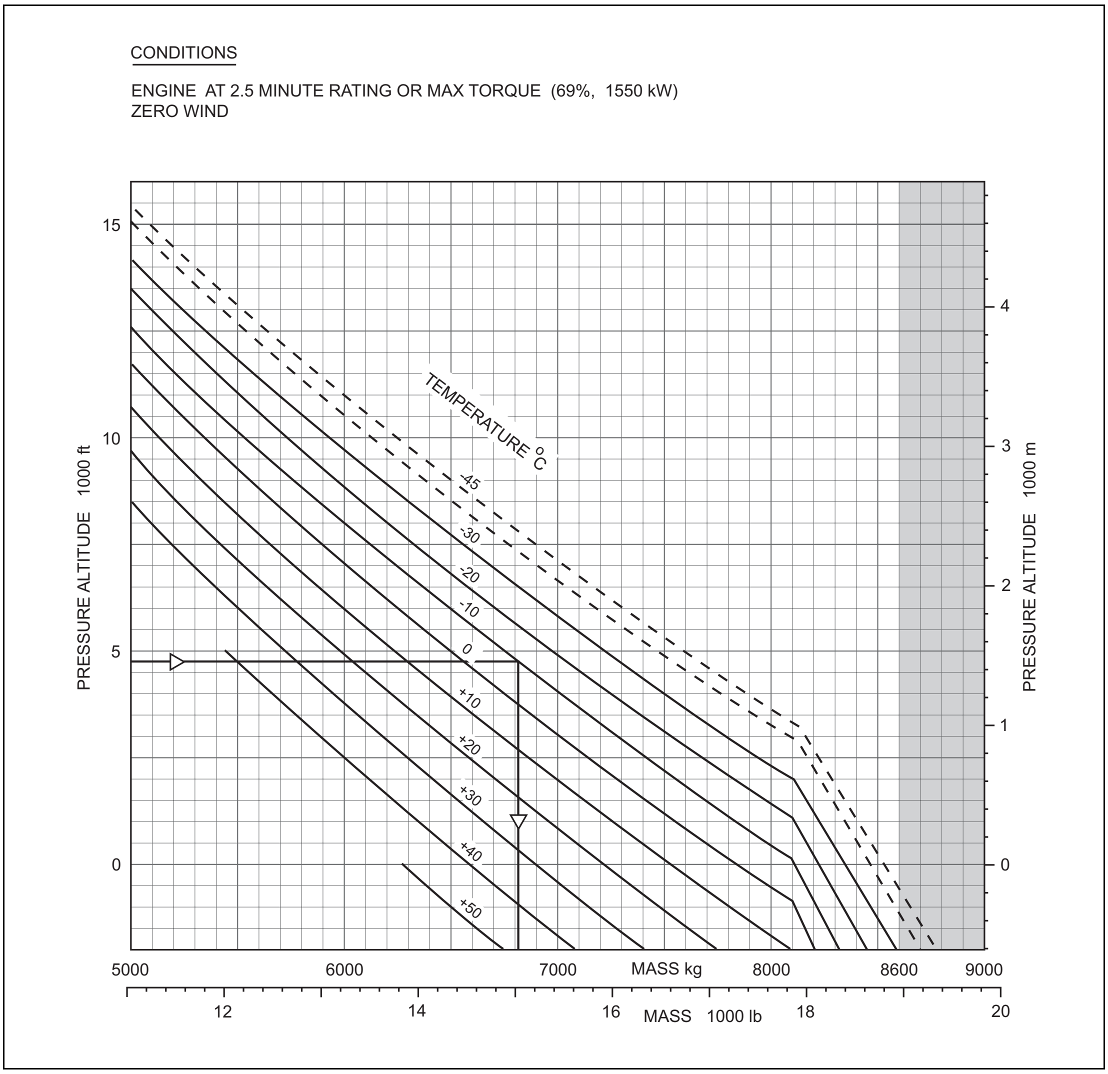


Figure 3.9 IGE Hover Performance – Single Engine (Height up to 15 ft)

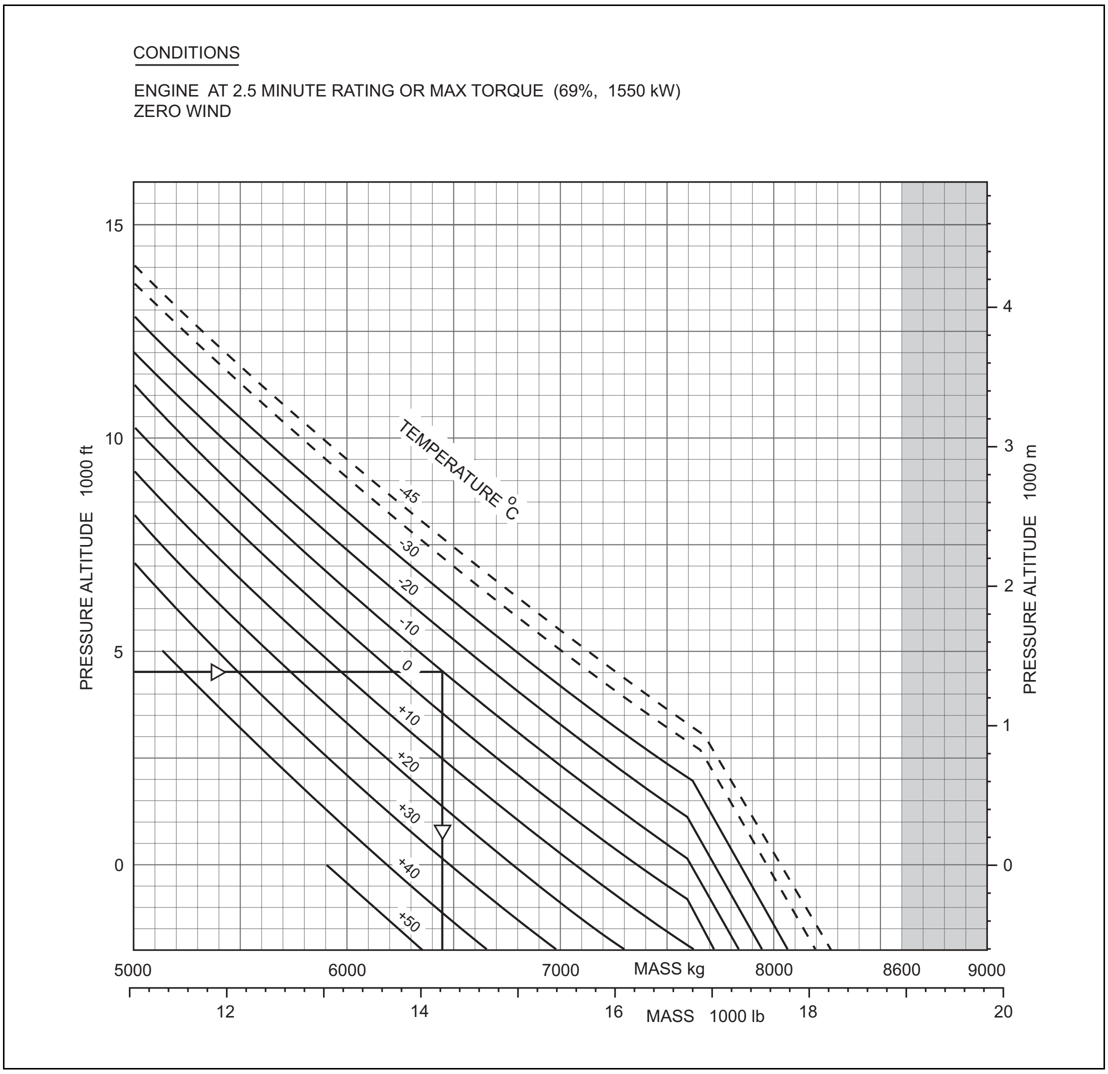


Figure 3.10 OGE Hover Performance – Single Engine (above 15 ft)

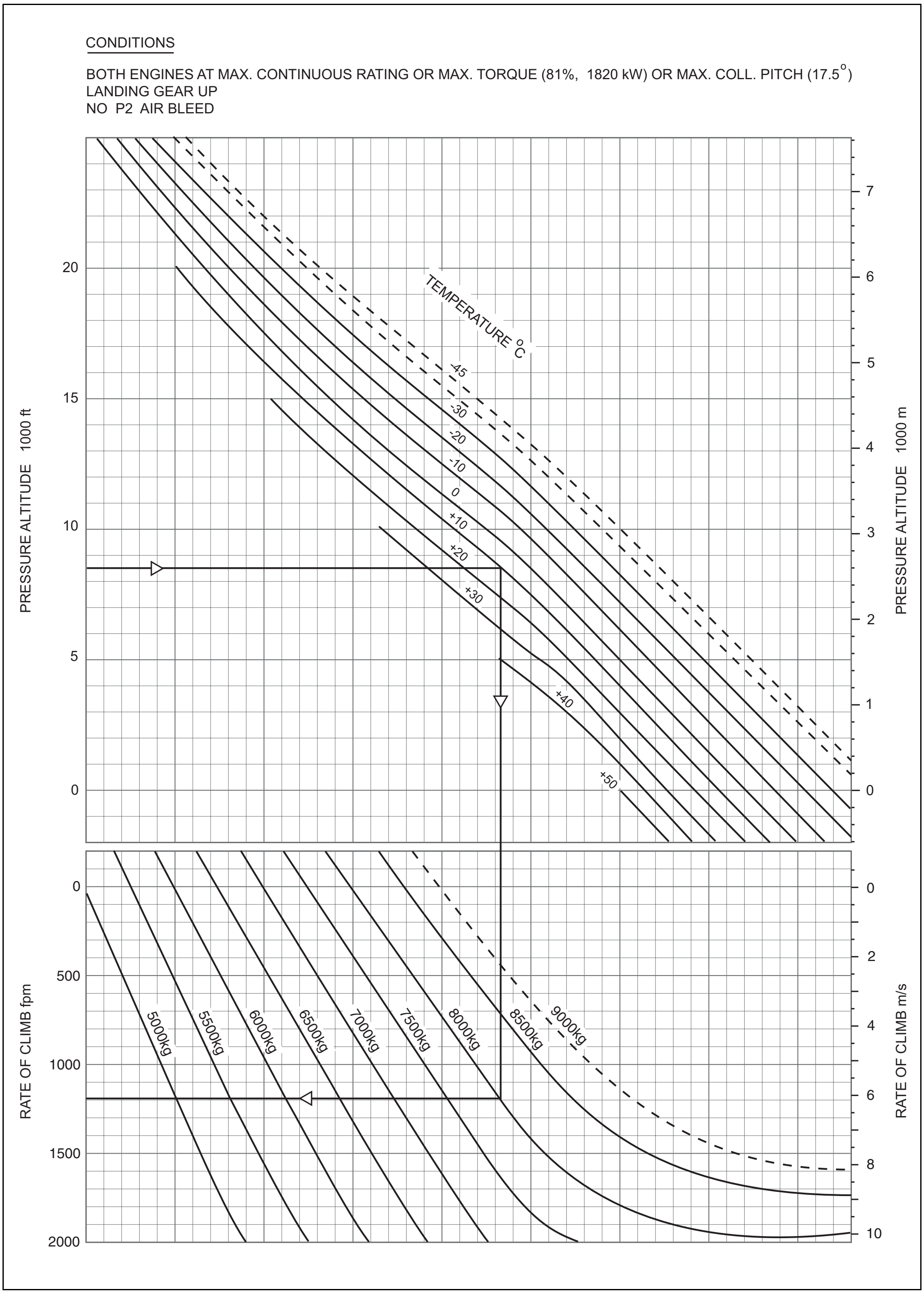


Figure 3.11 Rate of Climb at V_Y – Two Engines

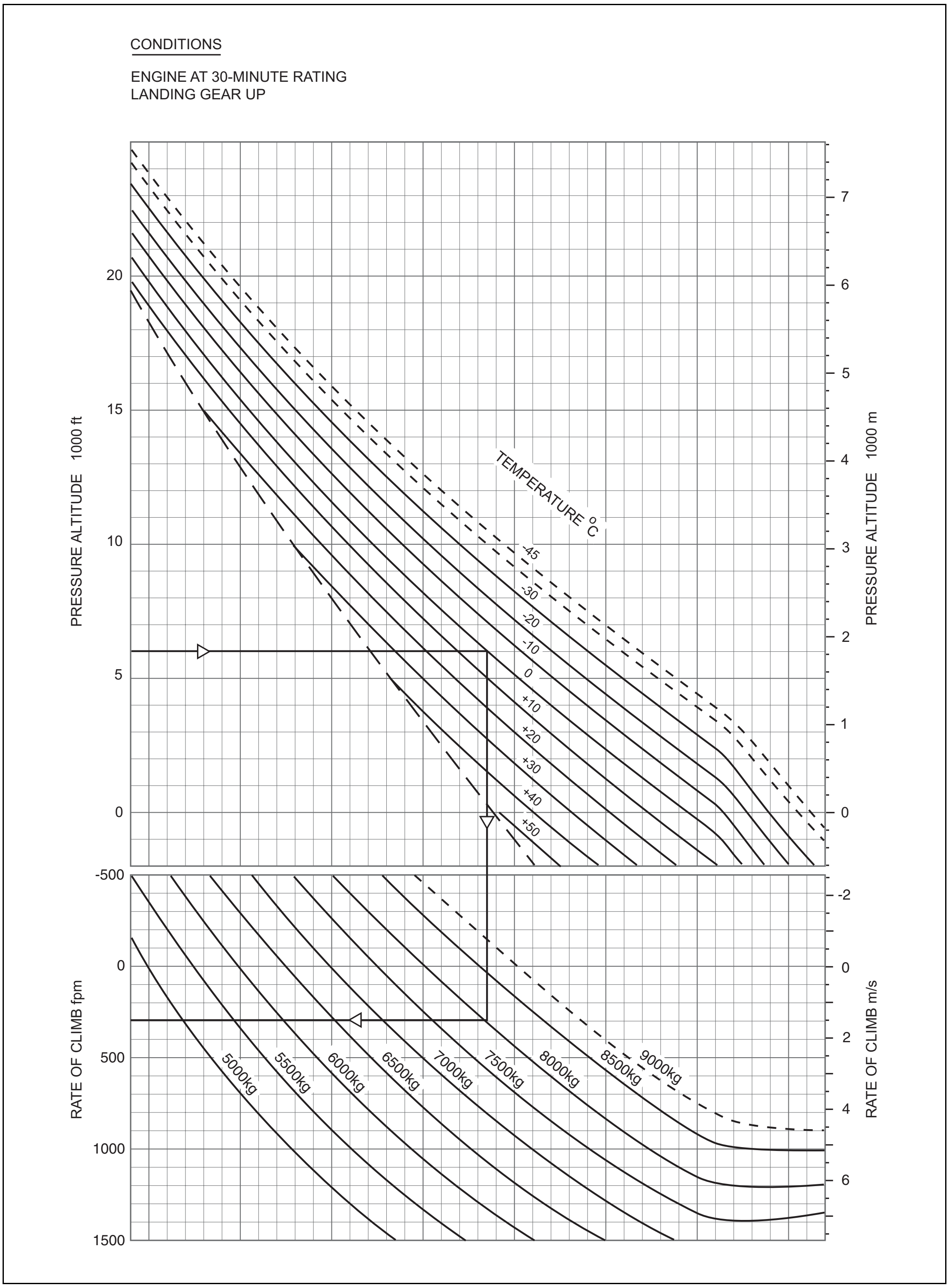


Figure 3.12 Rate of Climb at V_Y – Single Engine

3.2 Additional Performance Data

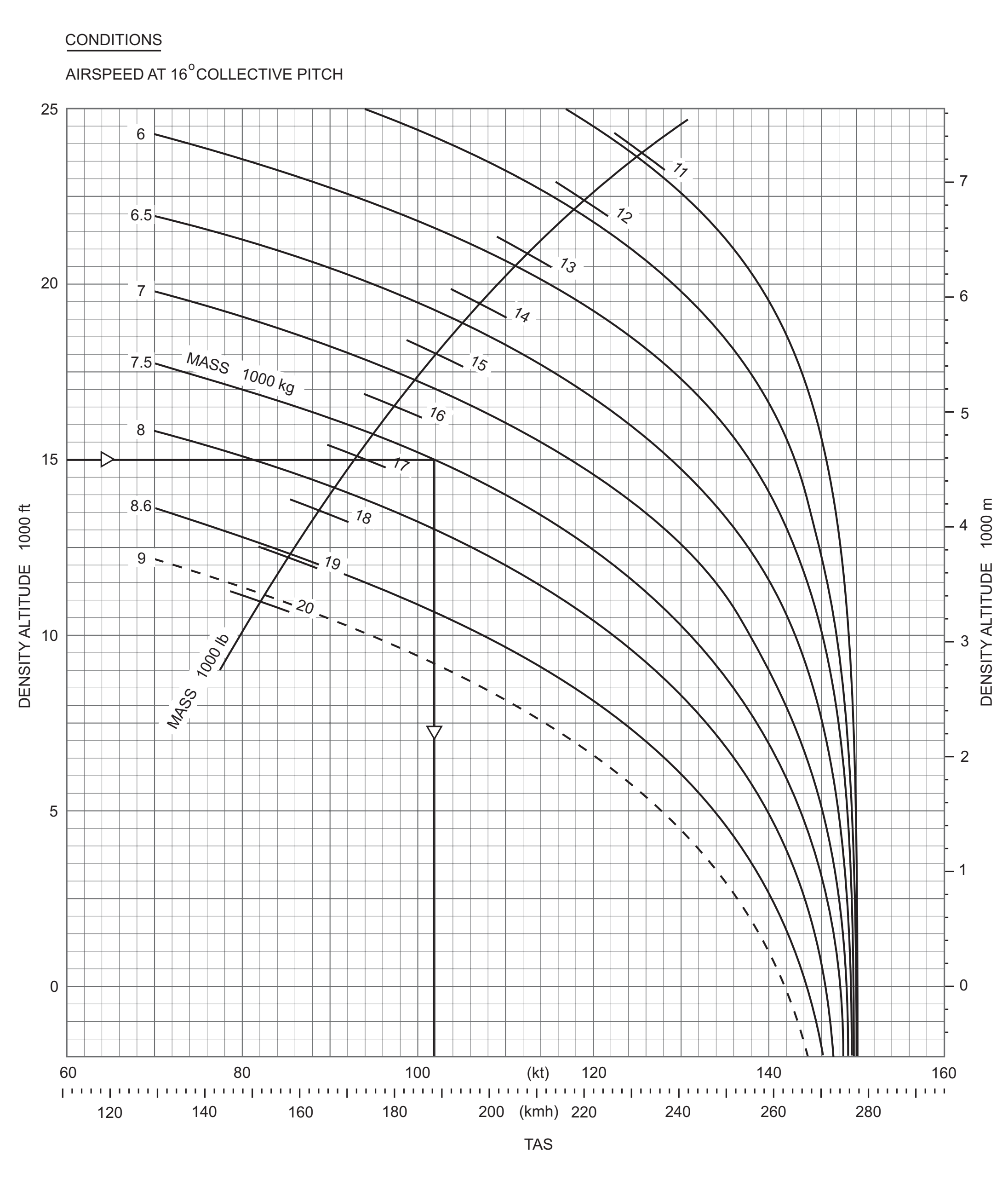


Figure 3.13 Airspeed in Level Flight – Two Engines

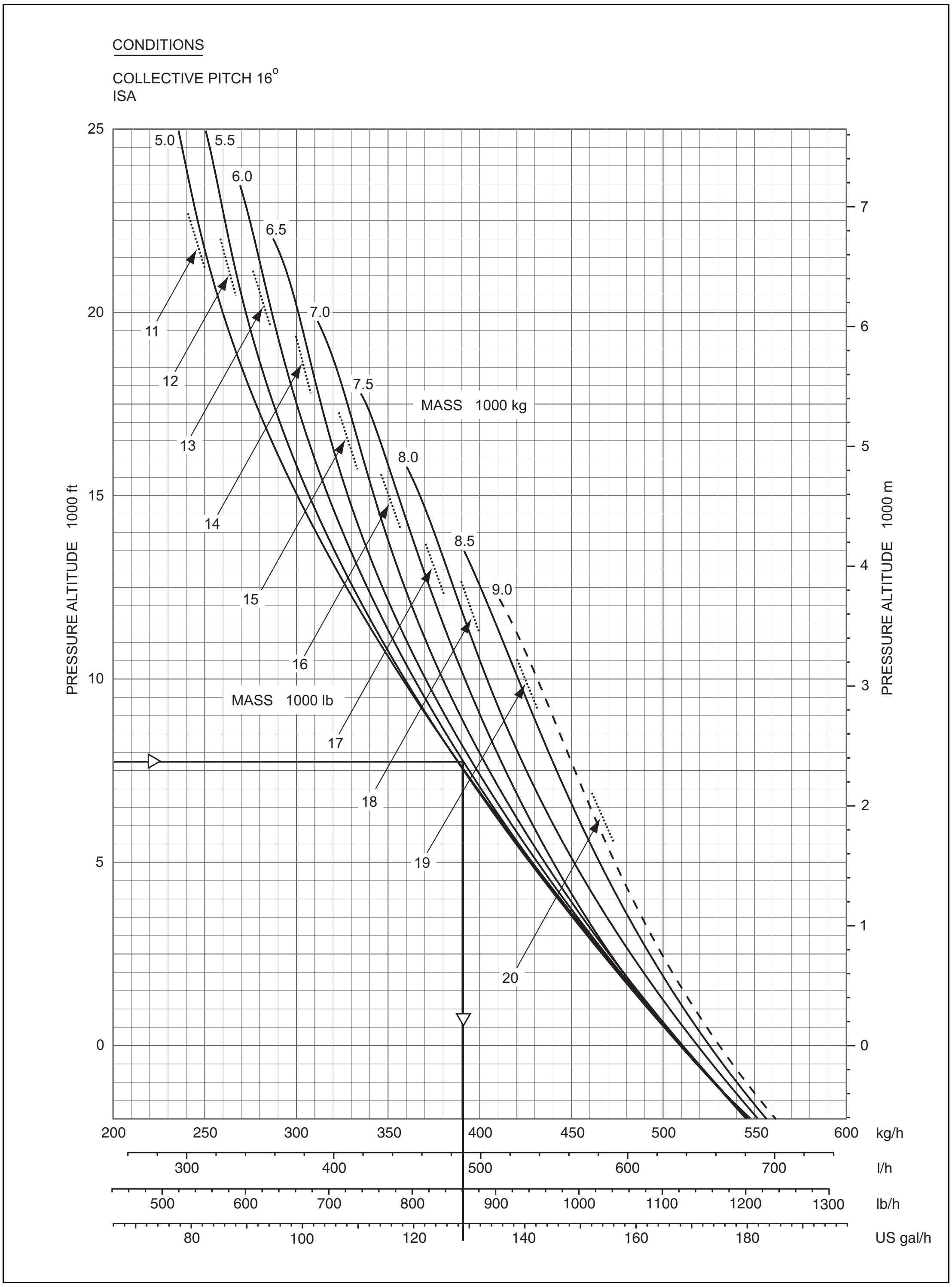


Figure 3.14 Hourly Fuel Consumption – Two Engines Cruise

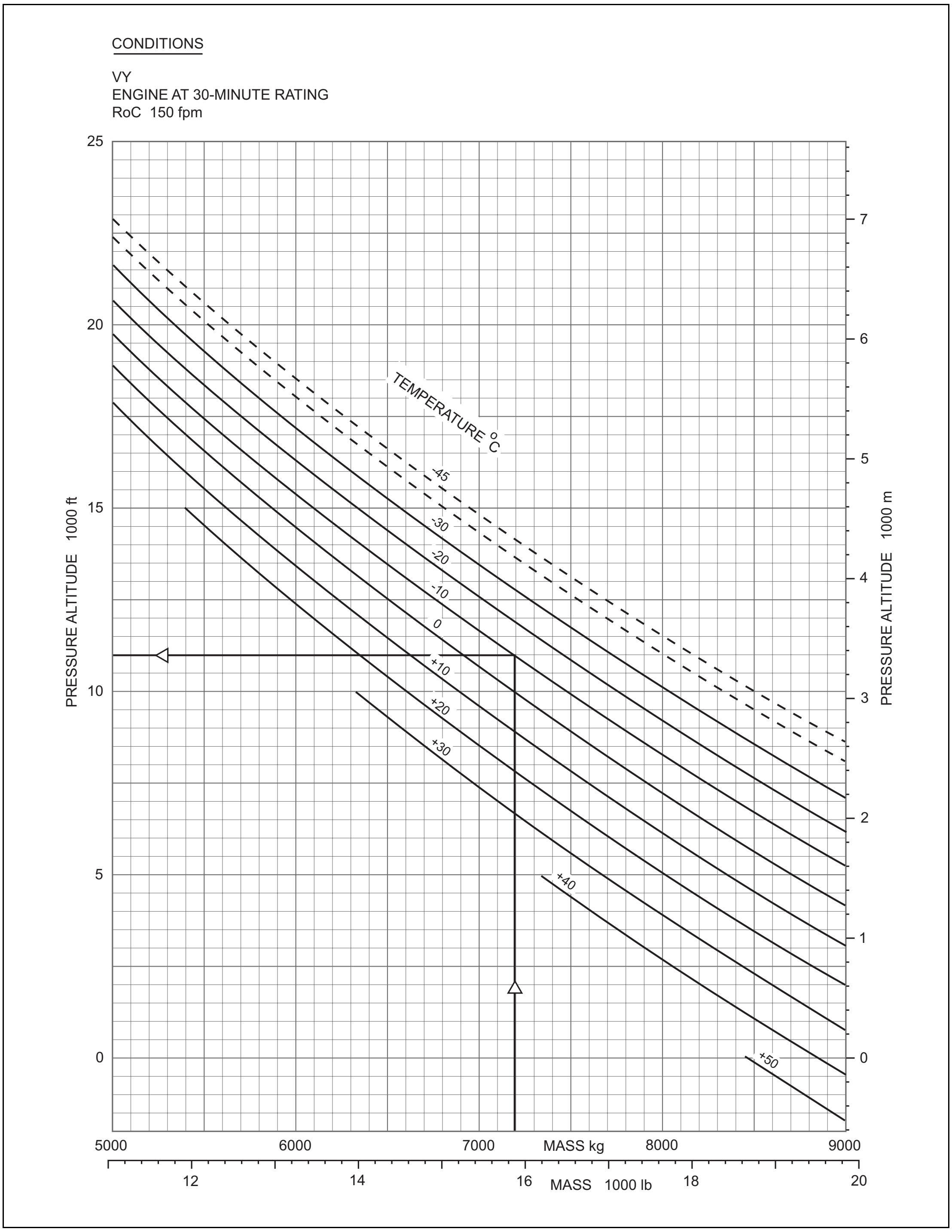


Figure 3.15 Service Ceiling – One Engine

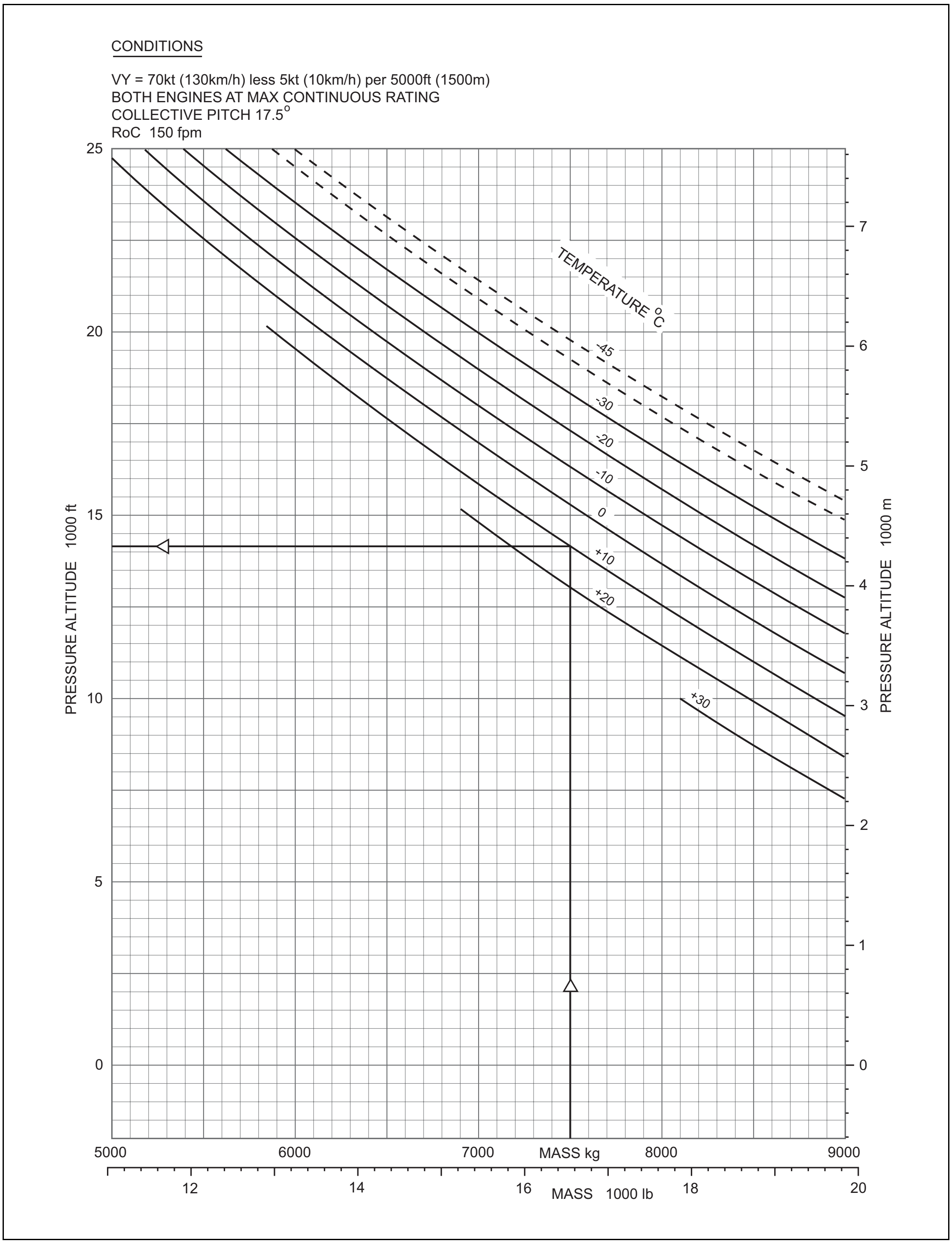
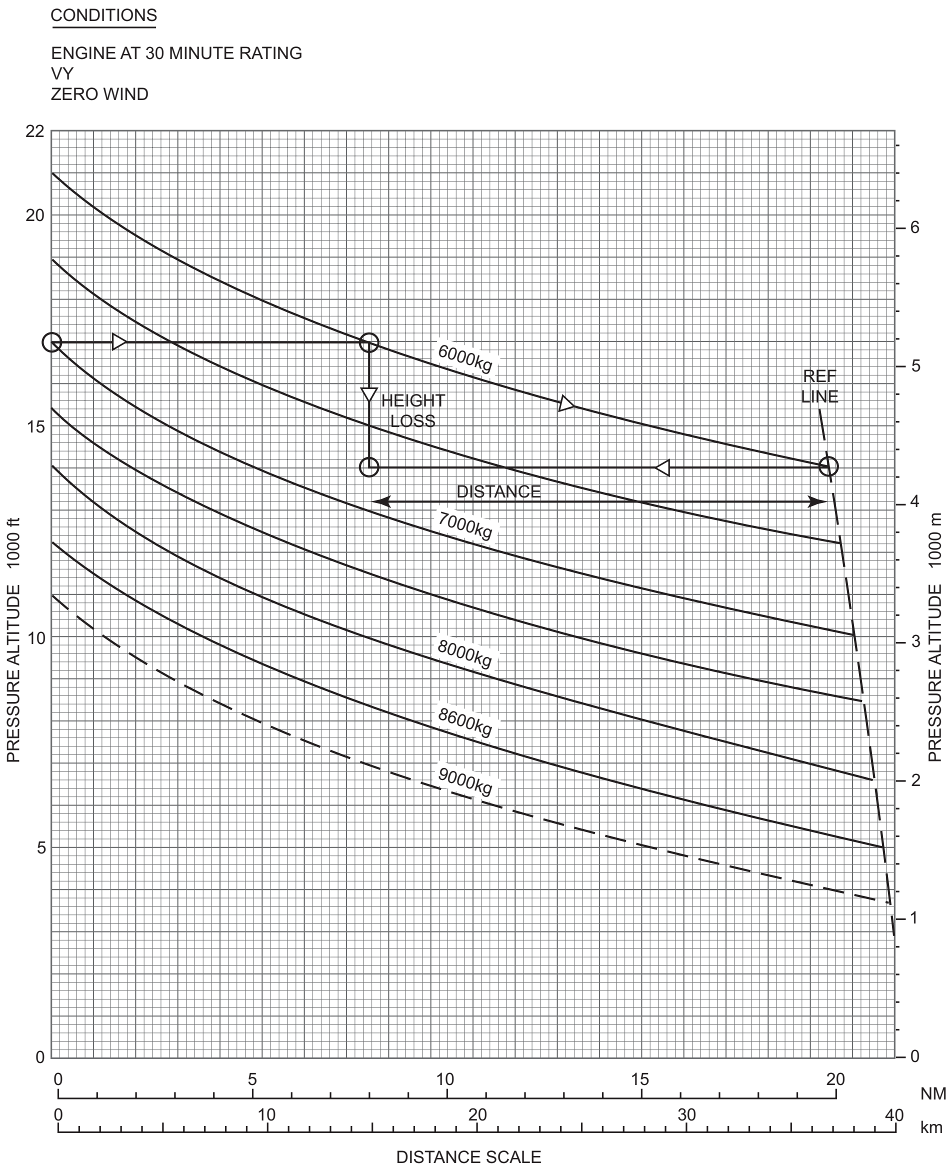


Figure 3.16 Service Ceiling – Two Engines



Enter at pressure altitude and move horizontally to mass line and down mass line to reference line
Move vertically down from first intercept point and horizontally to the left from the second point
Read off the height loss from the graph
Measure the distance and transfer to bottom distance scale to find distance required

EXAMPLE:

Pressure Altitude 17000 ft, Mass 6000 kg
Height Loss 3000 ft
Distance Required 11.8 NM (22 km)

Figure 3.17 Height Loss and Distance Required to Re-establish Level Flight – One Engine

4 Mass and Balance

4.1 CG – Standard Definitions

The CG is defined by dimensions measured perpendicularly to the three basic datum planes. These planes are as follows:

a) A horizontal plane, the cabin floor datum, is the Z datum plane.

b) A vertical plane perpendicular to the cabin floor datum. This Y datum plane is the helicopter plane of symmetry. Dimensions to the left (port) are known as negative and dimensions to the right (starboard) as positive.

c) A vertical plane perpendicular to the two mentioned above, situated 4.67 m (183.86 in) forward of the centre of the main rotor. This is the X datum plane, from which the longitudinal reference stations are measured.

NOTE 1: The cabin floor datum is materialised by the surface of the cabin floor.

NOTE 2: The helicopter centreline direction runs parallel to the line of intersection of the Y plane and the Z plane.

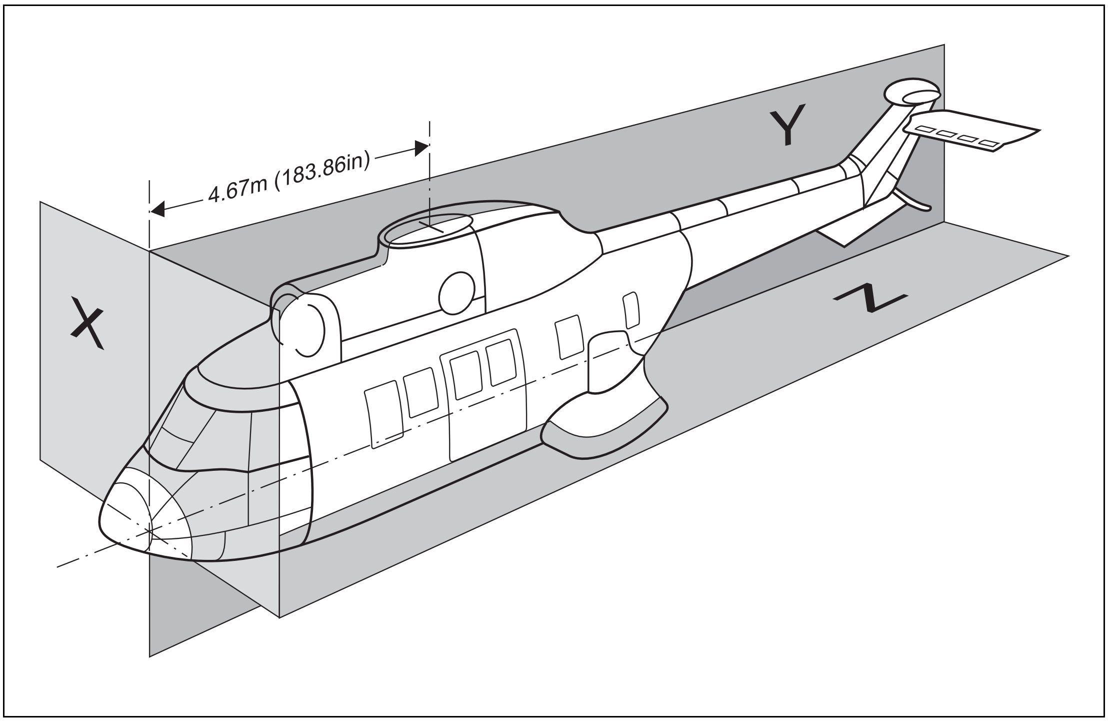


Figure 3.18 Helicopter Datum Planes

CG location limits are never to be exceeded (see Section 3, paragraph 2.2).

CAUTION: A CG LOCATION WHICH IS CORRECT ON TAKE-OFF MAY CHANGE IN THE COURSE OF THE MISSION, DUE TO FUEL MASS REDUCTION OR LOADING VARIATION, AND SO EXCEED ACCEPTABLE LIMITS.

a) Longitudinal CG must be the more closely watched.

b) Lateral CG need be considered only in very asymmetric loading configurations.

4.2 Helicopter Longitudinal Reference Stations

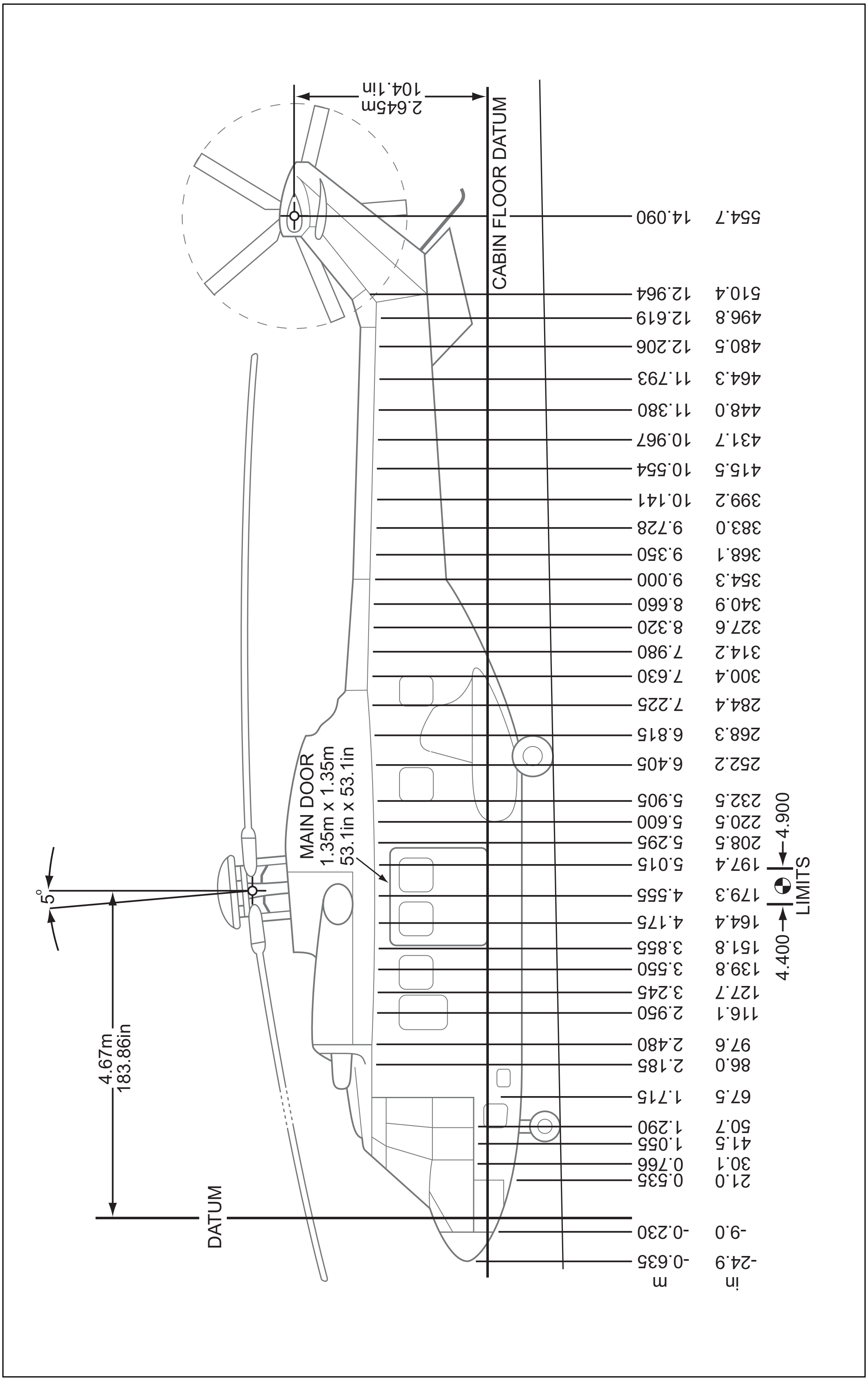


Figure 3.19 Helicopter Longitudinal Reference Stations

4.3 Calculating Longitudinal CG Location

4.3.1 Method

The distance from the CG of the helicopter to the datum plane is found by means of the following formula:

$$\frac{\text{Sum of moments}}{\text{Sum of masses}} = \text{CG}$$

a) Determine the maximum permissible take-off mass.

b) Note the equipped empty mass.

c) Refer to tables given, then total masses and moments.

d) Calculate CG location.

e) Check that CG falls within permissible limits.

4.3.2 Example:

		Mass (kg)	CG Location	Moment (kg m)
Equipped Empty Mass		4,700	4.60	21,620
Crew:	Pilot + Co-pilot	160	1.28	205
Fuel:	Filled up (2,367 litres)	1,870		8,241
Load:	Forward pallet	400		1,556
	Aft pallet	600		3,414
		7,730		**35,036**

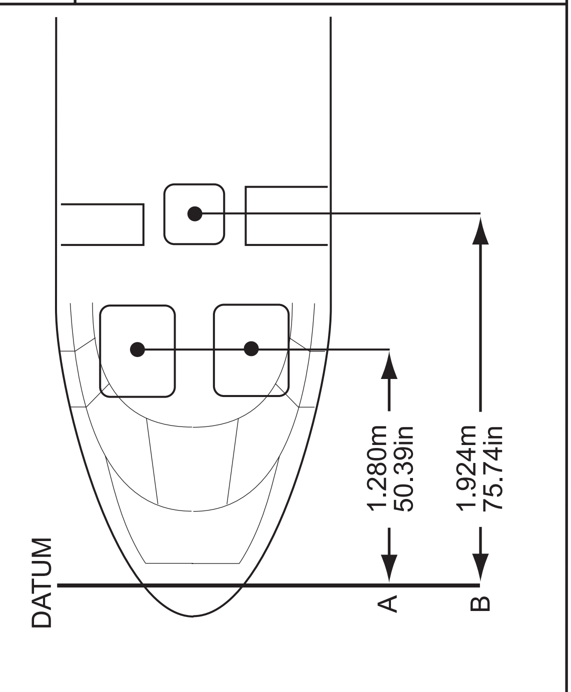
$$\text{CG Balance Arm} = \frac{35{,}036 \text{ kg m}}{7{,}730 \text{ m}} = 4.53 \text{ m}$$

Therefore, the CG is within permissible limits (see Section 3, paragraph 2.2).

4.4 Longitudinal Location of Variable Loads

4.4.1 Crew – Mass and Longitudinal Moments

CREW - WEIGHTS & LONGITUDINAL MOMENTS

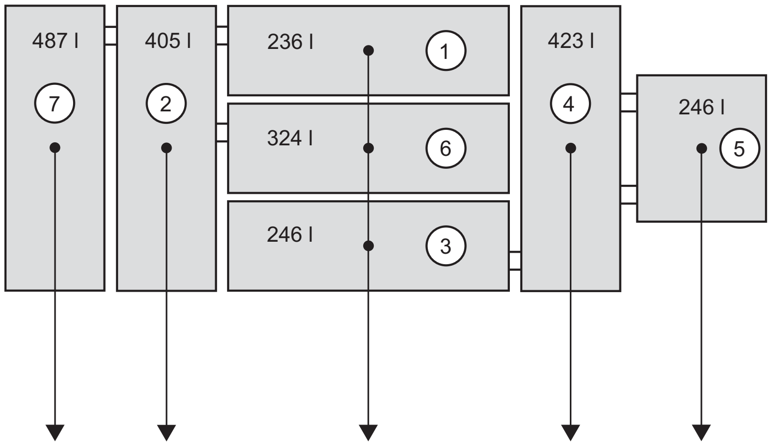


MASS kg	MOMENT kg m A	MOMENT kg m B
50	64	96
60	77	115
70	90	135
80	102	154
90	115	173
100	128	192
110	141	212
120	154	231
130	166	–
140	179	–
150	192	–
160	205	–
170	218	–
180	230	–
190	243	–

MASS lb	MOMENT lb in A	MOMENT lb in B
100	5039	7574
120	6047	9089
140	7055	10604
160	8062	12118
180	9070	13633
200	10078	15148
220	11086	16663
240	12093	18178
260	13101	–
280	14109	–
300	15117	–
320	16125	–
340	17137	–
360	18140	–
380	19148	–
400	20156	–

Figure 3.20 Crew Location and Moments

4.4.2 **Fuel – Mass and Longitudinal Moments**



Longitudinal reference stations		2.850m	3.550m	4.575m	5.600m	6.340m
Quantity		Moments kg m				
Litres	kg (d=0.79kg/l)					
50	40	114	142	183	224	253
100	79	226	280	361	442	500
150	119	340	422	544	666	754
200	158	452	560	722	884	1001
236	186			**851 (Tank 1)**		
246	194			**887 (Tank 3)**		**1230**
250	197	563	699		1103	
300	237	678	841		1327	
324	256			**1171 (Tank 6)**		
350	276	789	979		1545	
400	316	904	1121		1769	
405	320		**1136**			
423	334				**1870**	
450	355	1016				
487	385	**1096**				

Figure 3.21 Fuel Location and Moments

4.4.3 Fuel Transfer – Mass and Longitudinal Moments

FUEL - MASSES & LONGITUDINAL MOMENTS		
QUANTITY		CHANGES IN FLIGHT WITH TRANSFER AS PER RECOMMENDED PROCEDURE
LITRES	kg	MOMENTS kg m
100	79	361
200	158	723
300	237	1084
400	316	1446
500	395	1809
600	474	2178
700	553	2549
800	632	2923
900	711	3292
1000	790	3665
1200	948	4228
1400	1106	4789
1600	1264	5397
1800	1422	6136
2000	1580	6881
2200	1738	7630
2367	1870	8241

US gal	lb	MOMENTS lb in
50	329.5	59346
100	659.0	119351
150	988.5	178631
200	1318.0	239731
250	1647.5	300635
300	1977.0	351036
350	2306.5	396833
400	2636.0	443137
450	2965.5	500872
500	3295.0	562357
550	3624.5	623595
600	3954.0	684951
626	4120.0	715321

Figure 3.22 Standard Tanks in 7-Tank Version (6 Tanks + Centre Tank)

NOTE: Figure 3.23 shows the fuel CG limits defining the range between fuel transfers performed at the beginning and at the end of a flight. For fuel transfers performed at any other time the CG falls within this range. The solid line on Figure 3.23 depicts the recommended fuel transfer procedure.

4.4.4 **Fuel Transfer – CG Balance Arm Location**

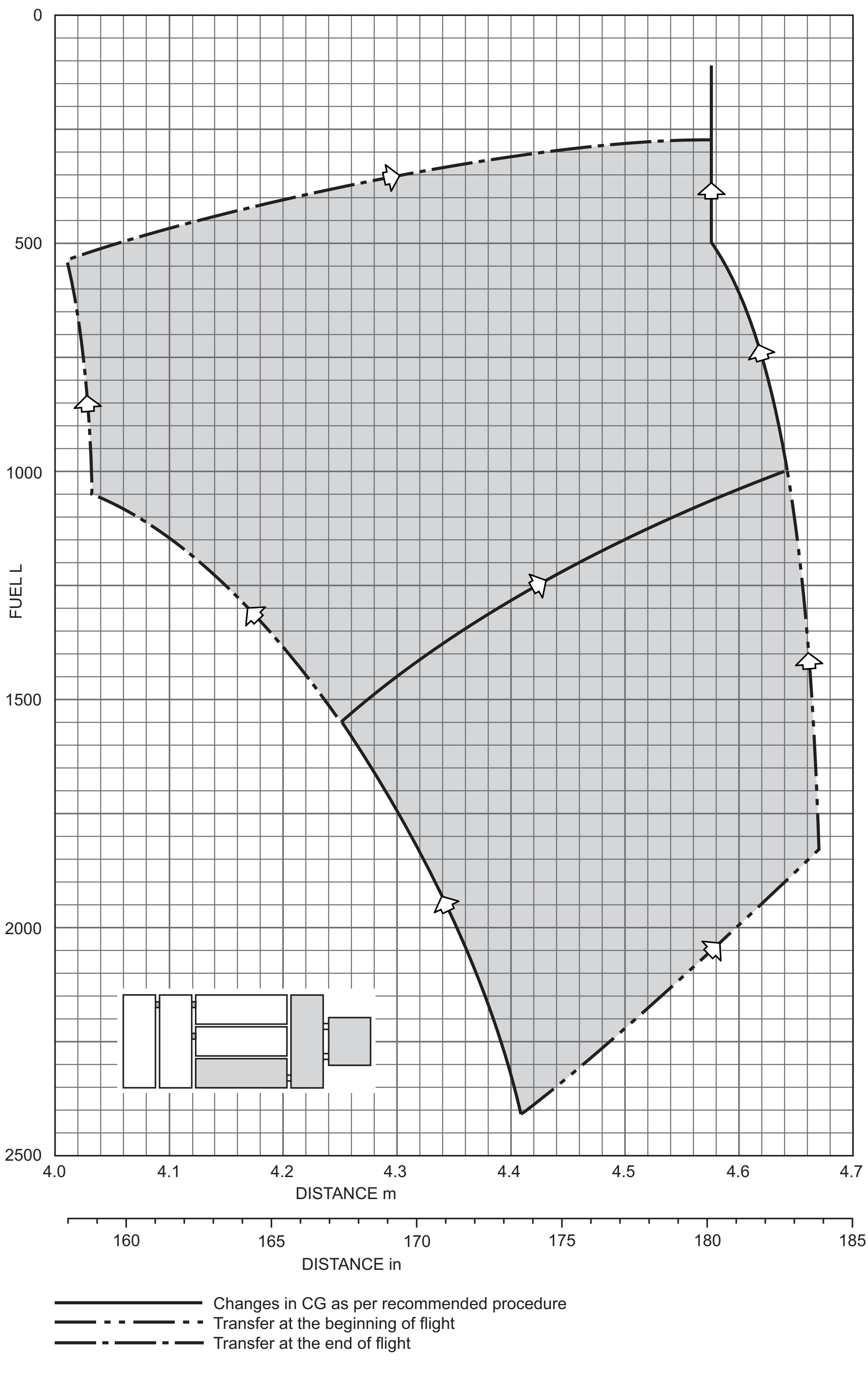


Figure 3.23 Changes in Fuel CG Location in 7-Tank Version

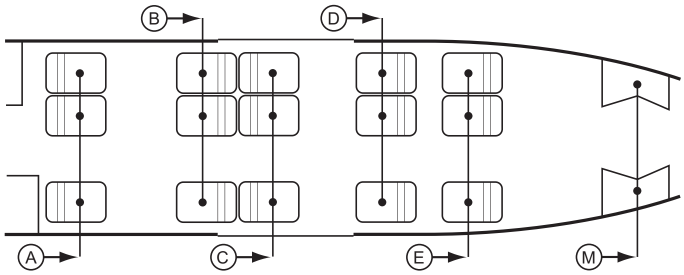
4.4.5 Balance Arms for Various Seat Layouts

LOCATIONS OF: PASSENGERS, VIPs & WOUNDED

NOTE: The total moment is calculated with a unit weight of 77kg (170lb) per passenger

15 SEAT VIP LAYOUT

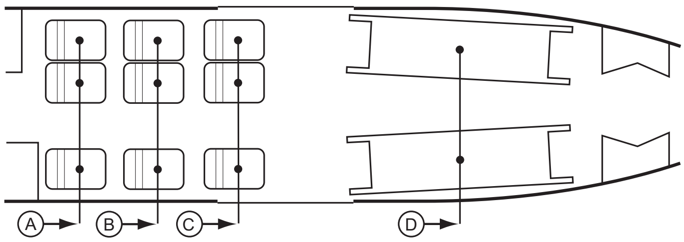
A = 2.54m (100in)
B = 3.75m (148in)
C = 4.43m (174in)
D = 5.57m (219in)
E = 6.50m (256in)
M = 7.98m (314in)



Total Moment of Passengers = 5264 kg m (456932 lb in)

6 STRETCHER AMBULANCE LAYOUT

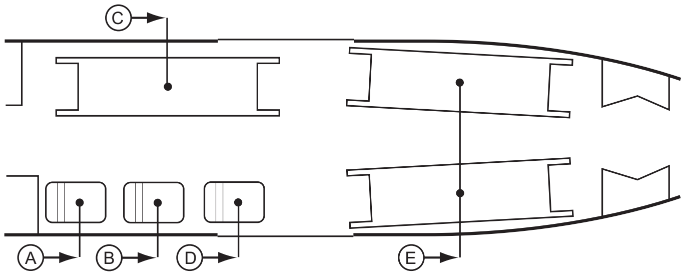
A = 2.54m (100in)
B = 3.31m (130in)
C = 4.09m (161in)
D = 6.05m (238in)



Total Moment of Passengers + 6 Wounded = 5090 kg m (441843 lb in)

9 STRETCHER AMBULANCE LAYOUT

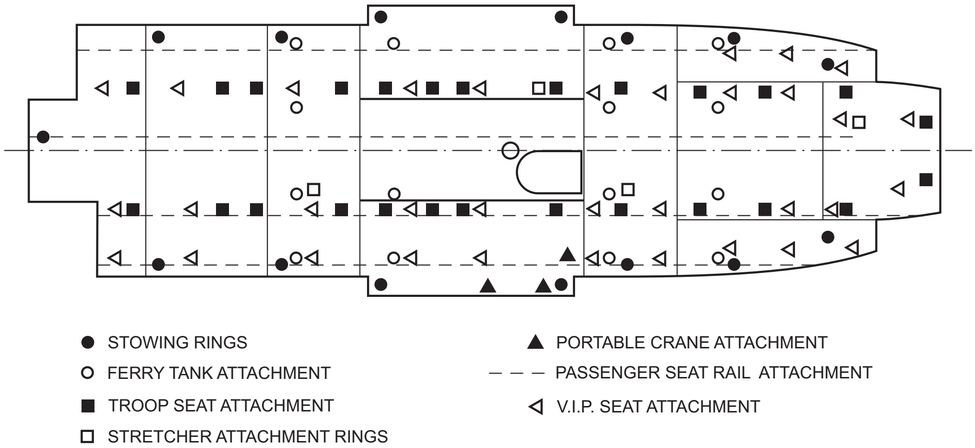
A = 2.54m (100in)
B = 3.31m (130in)
C = 3.36m (132in)
D = 4.09m (161in)
E = 6.05m (238in)



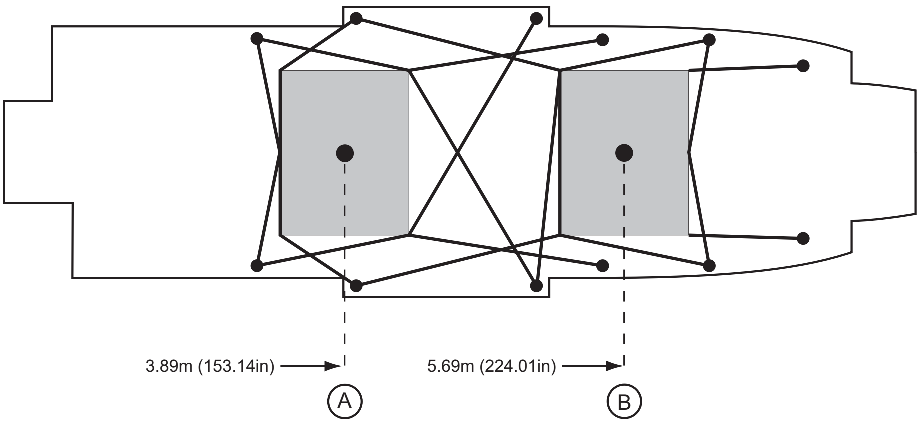
Total Moment of Passengers + 9 Wounded = 4336 kg m (376353 lb in)

Figure 3.24 Transport of Passengers

4.4.6 Traffic Load – Mass and Longitudinal Moments



CAUTION WHEN LOADING A SINGLE PALLET, IT MUST BE INSTALLED IN THE CG NEUTRAL POSITION (DATUM + 4.700m)



LONGITUDINAL MOMENTS					
MASS kg	MOMENT (kg m)		MASS lb	MOMENT (lb in)	
	A	B		A	B
100	389	569	200	30628	44802
200	778	1138	400	61256	89604
300	1167	1707	600	91884	134406
400	1556	2276	800	122512	179208
500	1945	2845	1000	153140	224010
600	2334	3414	1200	183768	268812
700	2723	3983	1400	214396	313614
800	3112	4552	1600	245024	358416
900	3501	5121	1800	275652	403218
1000	3890	5690	2000	306288	448020
			2200	336908	492822

Figure 3.25 Loads in Cabin

4.5 Longitudinal and Lateral Location of External Loads

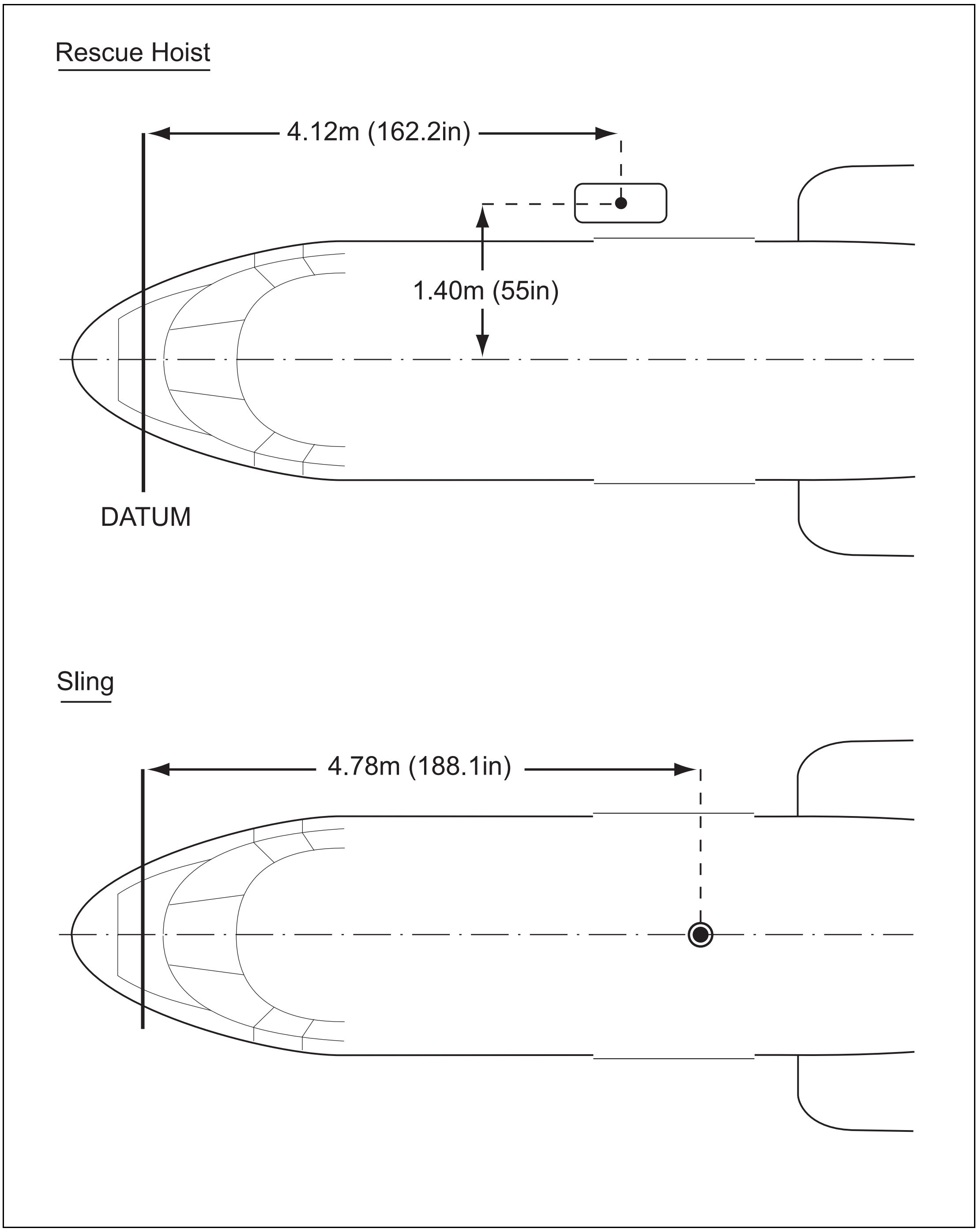


Figure 3.26 Longitudinal and Lateral Location of External Loads

4.6 Approximate Masses and Longitudinal Moments of Removable Optional Equipment Items

APPROXIMATE MASSES & LONGITUDINAL MOMENTS OF REMOVABLE OPTIONAL EQUIPMENT ITEMS

DESCRIPTION	MASS kg	MASS lb	MOMENT kg m	MOMENT lb in
Constant-speed hydraulic hoist installation with fixed arm	38.6	85.1	160	13907
Variable-speed hydraulic hoist installation with fixed arm	43.1	95.02	177.7	15428
Sling installation 4.5 metric tons	22	48.8	105.8	9183
Sling installation 3 metric tons	10.8	23.8	52.6	4565
NATO type stretcher	13.7	30.2	(see Figure 3.25)	
Access ladder	7	15.5	58.9	5118
Ferry tank				
2 forward tanks (2 x 475 litres)	65	143	246	21337
2 aft tanks (2 x 475 litres)	65	143	374	36428
Pod mounted freon air conditioning unit installation	73.1	161.1	158	13735
Mean seat mass				
single troop seat	4	8.8		
2-seat troop bench	4	8.8		
4-seat troop bench	13	28.7		
VIP or comfort seats:				
- single seat	10	22		
- 2-seat bench	15	33		

Figure 3.27 Approximate Masses and Longitudinal Moments of Removable Optional Equipment Items

5 Supplement

5.1 Flight in Icing Conditions

5.1.1 Performance Data

5.1.1.1 General

The performance values may be affected by:

- the de-icing system current draw;
- the mass of the ice built-up on the airframe;
- partial clogging of the air intake screens which reduces the engine power at the same power rating;
- cyclic power increase during ice formation on the rotor.

The three cases described below have been considered:

Before Icing

- The de-icing system may be switched OFF or ON.
- No ice build-up on the airframe.
- No clogging of the air intake screens.
- No ice build-up on the rotor.

In Icing Conditions

- The de-icing system is switched ON.
- Ice build-up on the airframe.
- Partial clogging of the air intake screens.
- Ice build-up on the rotor with cyclic power increases.

After Icing

- The de-icing system may be switched OFF or ON.
- Residual ice build-up on the airframe.
- Residual clogging of the air intake screens.
- No ice build-up on the rotor.

NOTE 1: The penalties due to the residual ice build-up on the airframe and air intake screens disappear after flight into temperatures above 0°C, as soon as the ice has broken away from the airframe (in practice, when the windshield wipers and cockpit door jettison handles are free from ice). Then use the 'Before Icing' performance values.

NOTE 2: In the event of stand-by on ground in freezing fog, use performance data 'In Icing Conditions'.

5.1.2 Regulatory Performance Data

5.1.2.1 Hover Flight and Climbing

The following table gives the performance values for the three cases considered during a flight in icing conditions on one and two engines.

Table 3.1 Hover Flight and Climbing

	BEFORE ICING		IN ICING CONDITIONS	AFTER ICING	
De-icing system	OFF	ON	ON	OFF	ON
Mass in hover	BASIC	BASIC with t° f = t° + 3°C	BASIC with t° f = t° + 15°C	BASIC with t° f = t° + 7°C	BASIC with t° f = t° + 10°C
ROC at 45 kt	BASIC	BASIC with t° f = t° + 3°C	BASIC with t° f = t° + 20°C	BASIC with t° f = t° + 7°C	BASIC with t° f = t° + 10°C

In this table:

- The term 'BASIC' indicates that the corresponding basic performance chart (see Figures 3.7 to 3.17 in Section 3, paragraph 3) can still be used.
- The term 'BASIC with t°f = t° + n°C' indicates that the corresponding basic performance chart in Section 3, paragraph 3 must be used, entering the graph with t°f (a nominal temperature) obtained by adding the n°C from Table 3.1 to t° (the actual outside air temperature).

5.1.2.2 50-foot Clearance Distances on Take-off or on Landing

The values given in Section 3, paragraph 7 of this manual (maximum distances effective for an authorised take-off altitude, temperature and mass conditions) can still be used in the cases considered, i.e. 'Before Icing', 'In Icing Conditions', and 'After Icing'.

5.1.2.3 Category A Operation

All the procedures and performance data given in Section 3, paragraph 3 of this manual remain applicable. To enter a graph for Category A operation use a nominal temperature, obtained by adding the values given in Table 3.2 to the actual outside temperature.

Table 3.2 Category A Operation

	BEFORE ICING		IN ICING CONDITIONS	AFTER ICING	
De-icing system	OFF	ON	ON	OFF	ON
Determine performance values from charts in Section 3, paragraph 3	BASIC	BASIC with t° f = t° + 3°C	BASIC with t° f = t° + 20°C	BASIC with t° f = t° + 7°C	BASIC with t° f = t° + 10°C

All the performance values given in Section 3, paragraph 3 of this manual are effective for all mass, balance and temperature conditions and remain applicable in the three situations considered, i.e. 'Before Icing', 'In Icing Conditions' and 'After Icing'.

5.1.3 Supplementary Performance Data

The supplementary performance values are obtained from the corresponding charts in Section 3, paragraph 3 of this manual by applying the corrections given in Table 3.3.

Table 3.3 Supplementary Performance Data

	BEFORE ICING		IN ICING CONDITIONS	AFTER ICING	
De-icing system	OFF	ON	ON	OFF	ON
Speeds in level flight (Figure 3.13)	BASIC - 1.5 kt	BASIC - 1.5 kt	See Figure 3.28	BASIC - 1.5 kt	BASIC - 1.5 kt
Fuel consumption in level flight (Figure 3.14)	BASIC + 1%	BASIC + 4 kg/h	BASIC + 8%	BASIC + 6 kg/h	BASIC + 10 kg/h
Service ceiling for 1 or 2 engines (Figures 3.15 and 3.16)	BASIC	BASIC with $t^\circ f = t^\circ + 3^\circ C$	BASIC with $t^\circ f = t^\circ + 20^\circ C$	BASIC with $t^\circ f = t^\circ + 7^\circ C$	BASIC with $t^\circ f = t^\circ + 10^\circ C$

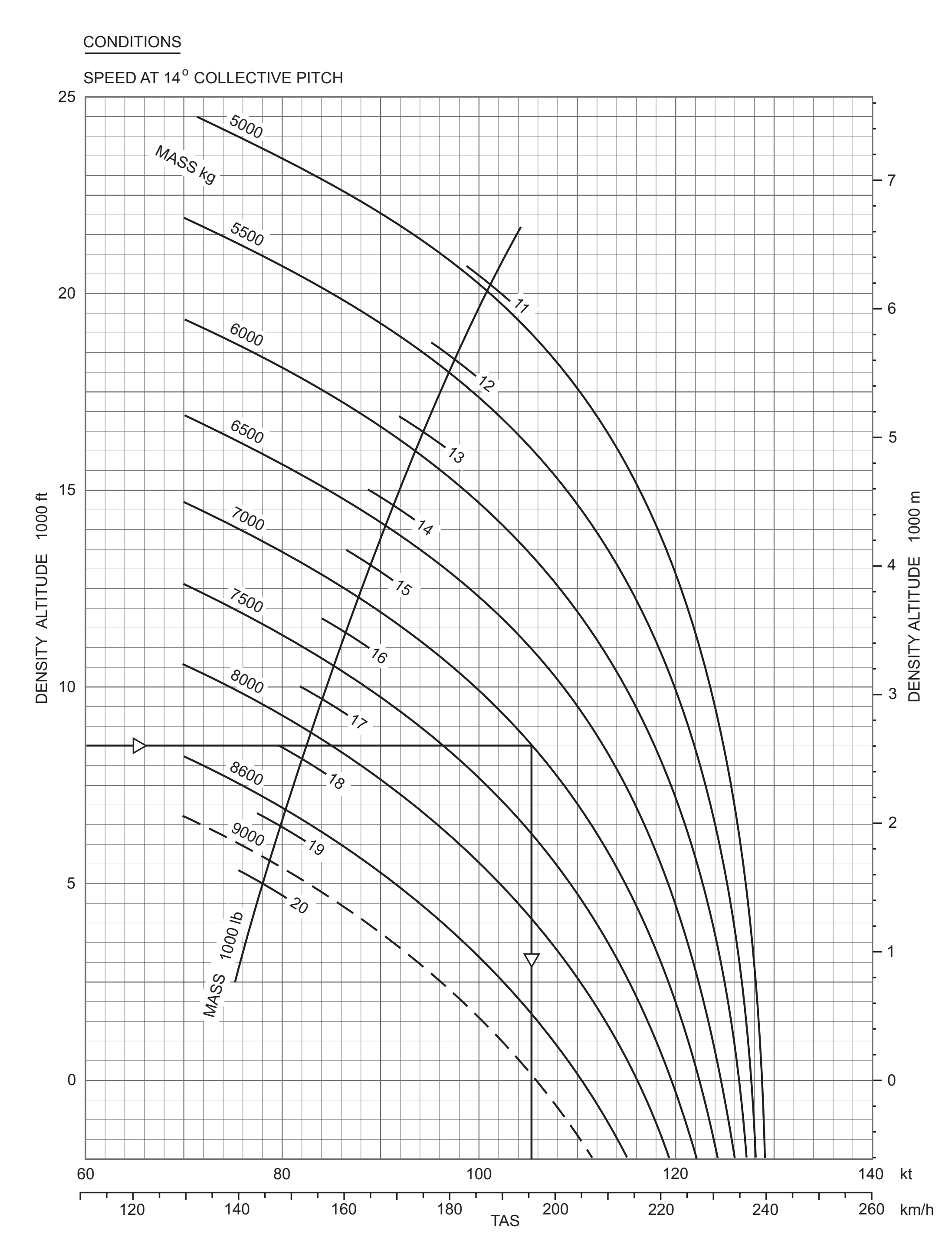


Figure 3.28 Speed in Level Flight in Icing Conditions – Two Engines

5.2 Category A Operation

IMPORTANT NOTE
The information contained in paragraph 5.2 and its associated sub-paragraphs supplements or supersedes the information given in Section 3, paragraphs 3 and 5.1.

5.2.1 General

The information given below applies exclusively to Category A operation of the helicopter.

Information given in the basic Category B Flight Manual applies to Category A except for limitations, procedures and performance particular to Category A described in this Supplement.

Symbols and definitions given below are used in this Supplement.

Table 3.4 Supplement Symbols and Definitions

CDP	Critical take-off decision point. At this point: • Normal landing is possible on the landing area if one engine fails BEFORE reaching this point. • Flight continuation is possible if an engine fails AFTER this point. The decision point is defined as CT - h1 combination or a V_1 - h1 combination.
CT	Critical decision time
h1	Critical decision height
LDP	Critical landing decision point. At this V1 - h1 combination point it is still possible to obtain the correct VTOSS whenever one engine fails, at a height equal to at least 35 ft (10 m) above the landing area.
V_1	Critical decision speed
V_{TOSS}	Take-off or landing safety speed. At that speed, the ROC is at least 100 fpm with: • one engine inoperative; • one engine inoperative at 2½-min rating; • landing gear extended and air bleeds (heating, demisting, etc.) shut off. Use Figure 3.39 to determine V_{TOSS} (45 kt minimum)
V_Y	Recommended ROC This speed allows at least 150 fpm climbing up to 1,000 ft (300 m) above take-off area with: • one engine inoperative; • one engine operating at 30-min rating; • landing gear retracted; • air bleeds shut off.

Performance and limitations are determined so as to permit:

1 Safe take-off and landing considering the ground available.

2 Climb on one engine along a predetermined path up to 1,000 ft (300 m) height above the take-off area. Safe clearance of obstacles along the take-off path is ensured by using the climb path data to determine the distance at which the maximum heights along the path are attained. The same climb path data is also used to determine the safe clearance of obstacles during the go-around procedure following an engine failure at the CDP or LDP.

5.2.2 **Operation on Clear Airfield**

5.2.2.1 **Limitations on Clear Airfield**

Apart from the specific limitations mentioned below, the limitations given in Section 3, paragraph 2 of this manual remain applicable.

Minimum crew

The minimum Category A crew consists of two members qualified to fly this type of helicopter.

- VFR flight: 1 pilot + 1 qualified crew member.
- IFR flight: 2 pilots.

Approved altitude/temperature envelope

- Altitude limits

  At take-off and landing:

  - 8,000ft (2,440 m) density altitude.

  In flight:

  - 25,000 ft (7,600 m) pressure altitude for masses up to 8,350 kg (18,410 lb).
  - 9,500 ft (2,895 m) pressure altitude for masses over 8,350 kg (18,410 lb).
- Temperature limits
  - Maximum temperature ISA +35^{o}C limited to +50^{o}C
  - Minimum temperature for normal operation -30^{o}C

Maximum permissible masses

The maximum permissible take-off, final approach and landing masses are indicated on Figure 3.29 as a function of pressure altitude and OAT.

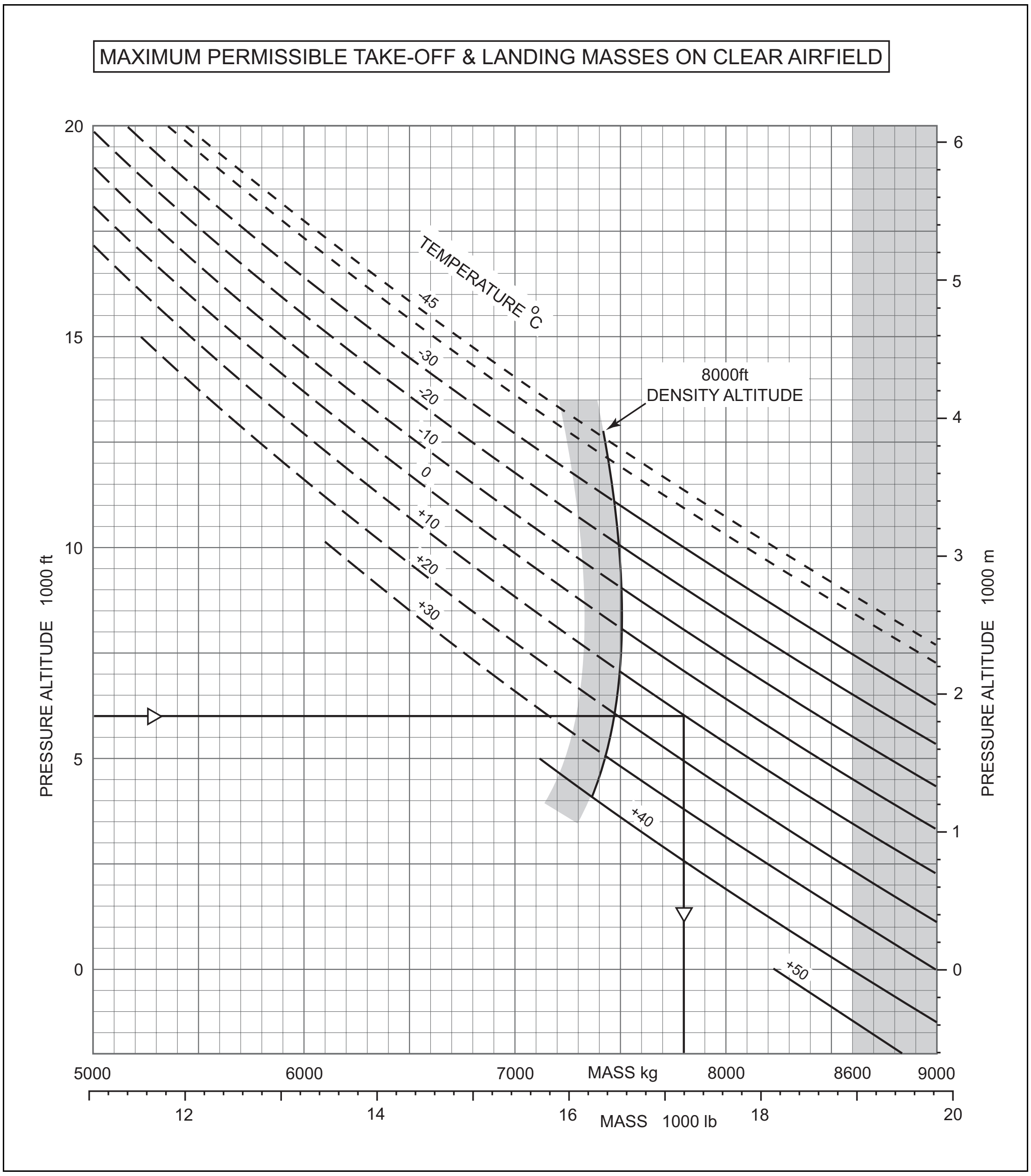


Figure 3.29 Maximum Permissible Take-Off and Landing Masses on Clear Airfield

5.2.2.2 Take-Off Procedures on Clear Airfield

CAUTION: TAKE-OFF TO BE PERFORMED WITH NOSE WHEEL LOCKED.

- **General**

Two typical take-off procedures are defined:

Procedure No. 1 was designed to permit take-off from the shortest possible clear airfield.

Procedure No. 2 is applicable to a take-off from an average length airfield; it permits acceleration at low height up to V_Y and penetration (V_Y being higher than the minimum IFR airspeed) at low height in IMC.

Accelerate-stop distances for aborted take-offs are given in Figure 3.40.

NOTE: Procedure Nos. 1 and 2 also apply to single-engine flight continuation after the failure of one engine.

Procedure No. 1 – Short Field Take-off

The take-off path has been divided into four segments (see Figure 3.30):

1st segment:	is defined as the take-off path section between hover and reaching 35 ft (10 m) at the V_{TOSS} (see Figure 3.39). Distance D1 is associated to this segment (see Figure 3.40).
2nd segment:	is defined as the take-off path section necessary to climb from 35 ft (10 m) to 200 ft (60 m) at V_{TOSS}. Distance D2 is associated to this segment (see Figure 3.42).
3rd segment:	is defined as the take-off path section necessary to accelerate, in level flight at 200 ft (60 m), from the V_{TOSS} to V_Y. Distance D3 is associated with this segment (see Figure 3.43).
4th segment:	is defined as the take-off path section necessary to climb at V_Y, from 200 ft (60 m) to 1,000 ft (300 m). Distance D4 is associated with this segment (see Figure 3.44).

Procedure No. 2 – Normal Take-off

The take-off path has been divided into two segments (see Figure 3.31):

1st segment:	is defined as the take-off path section between hover flight and passage to 35 feet (10 m).
2nd segment:	is defined as the climb path from 35 ft (10 m) up to 1,000ft (300 m) at V_Y.

NOTE: During the complete take-off phase and up to 1,000 ft (300 m) above ground for either of the above procedures, any equipment using bleed air (heating, air conditioning, etc.) must be switched off.

- **Normal Take-Off Procedures**

If following Procedure No. 1 (see previous page):

Determine take-off mass, V_{TOSS}, CT (CDP), and V_Y (see paragraph 5.2.4). Start forward flight from hover flight at 15 ft (4.5 m) as follows:

PILOT:
- Gives forward flight signal, simultaneously increases pitch by 1° (see NOTE 2) and tilts helicopter to retain an approximately constant height (max. nose-down attitude: 15°).

  NOTE 1: These simultaneous manoeuvres must be carried out within two seconds.

COPILOT:
- Starts stopwatch on pilot's signal and counts seconds out loud up to the critical time.

PILOT:
- Accelerates up to V_{TOSS} and starts to climb up while increasing speed to V_Y.
- Selects climbing pitch.

COPILOT:
- Retracts landing gear at V_Y.

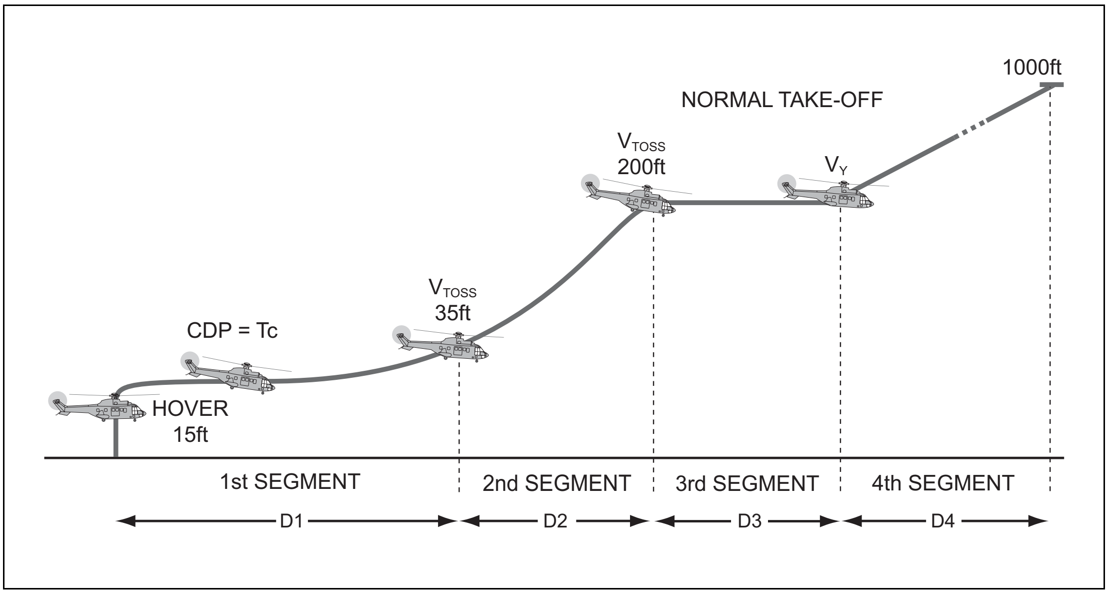


Figure 3.30 Normal Take-Off – Procedure No. 1

NOTE 2: To introduce forward flight progressively, the pitch may be increased to 0.5° instead of 1°. This method is recommended in conditions where critical time is lower than or equal to four seconds. This method requires:

- the CT to be double that given in Figure 3.40;
- the acceleration-stop distance corresponding to the new CT to be calculated;
- the distance to 35 feet (10 m) to be determined using the fictitious mass corresponding to the new CT (see Figure 3.41).

If following Procedure No. 2 (see page 36):

Determine take-off mass and V_1 (=V_Y). From hover flight at 15 ft (4.5 m), start forward flight as follows:

PILOT:
- Announces starting signal.
- Simultaneously increases pitch by 1° and tilts helicopter so as to retain an approximately constant height (max. nose down attitude: 15°).

  NOTE: These simultaneous manoeuvres must be carried out within two seconds.

COPILOT:
- Announces V_Y.

PILOT:
- Starts to climb at V_Y.

COPILOT:
- Retracts landing gear.

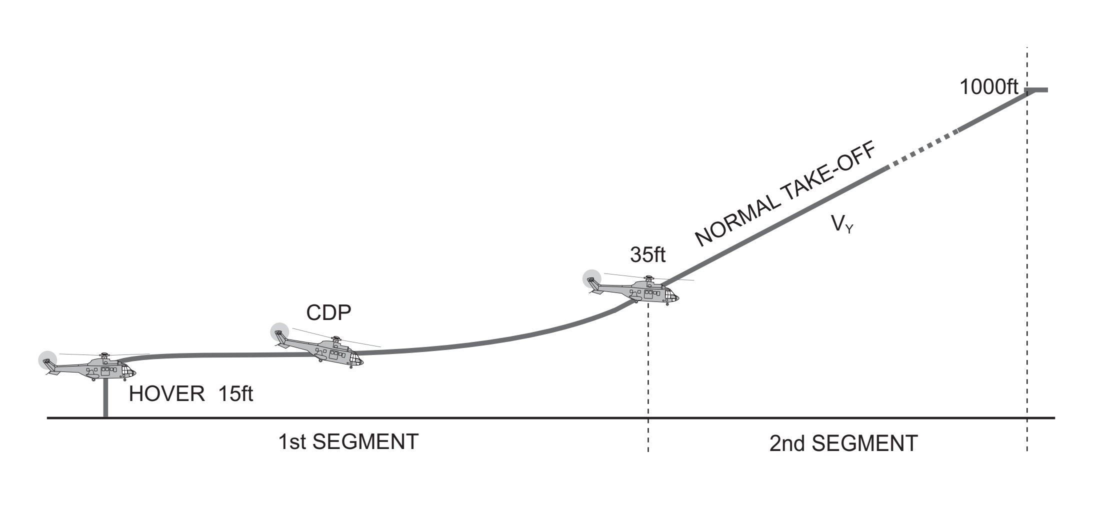


Figure 3.31 Normal Take-Off – Procedure No. 2

- **Engine Failure at Take-Off Emergency Procedures**

Engine failure before CDP

If following Procedure No. 1 – Short Field Take-off (see page 36):

Any engine failure before the CDP entails IMMEDIATE LANDING. Proceed as follows:

PILOT:
- Reduces pitch and speed while selecting appropriate nose-up attitude.
- Decreases attitude to 5° nose-up on ground approach and retains this attitude until touchdown.
- After touchdown, applies brakes to stop forward run, decreases collective pitch while resetting cyclic pitch stick to neutral.

COPILOT:
- Announces rotor rpm during complete manoeuvre.

Engine failure at or after CDP

If following Procedure No. 1 – Short Field Take-off (see page 36):

From the CDP, an engine failure does not hinder take-off. Proceed as follows:

PILOT:
- Selects NR = 245 rpm (92.5%) (pitch remains at 14° approx.) and retains this rating.

COPILOT:
- Announces rotor rpm.

PILOT:
- Accelerates up to V_{TOSS}.
- Retains speed up to 200 ft (60 m) above ground at minimum NR of 245 rpm (92.5%).
- At 200 ft (60 m), accelerates to V_y in forward flight.

COPILOT:
- Retracts landing gear.

PILOT:
- Continues climb at V_y while selecting 30-minute rating.

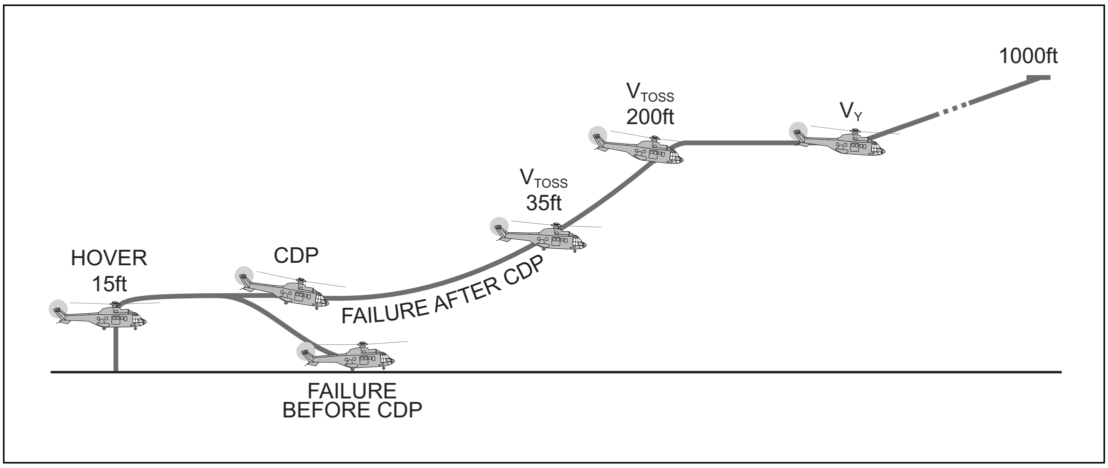


Figure 3.32 Engine Failure at Take-Off – Procedure No. 1

Engine failure before CDP

If following Procedure No. 2 (see page 36):

NOTE: In this case, follow the steps shown under 'Engine failure before CDP' on the previous page referring (accordingly) to Figure 3.32.

Engine failure at or after CDP

If following Procedure No. 2 (see page 36):

Whenever take-off proceeds:

PILOT:
- Selects NR = 245 rpm (92.5%) (pitch = 14° approx.).
- Climbs at constant V_Y.

COPILOT:
- Retracts landing gear.
- Announces 200 ft (60 m).

PILOT:
- Selects 30-minute rating and continues climb.

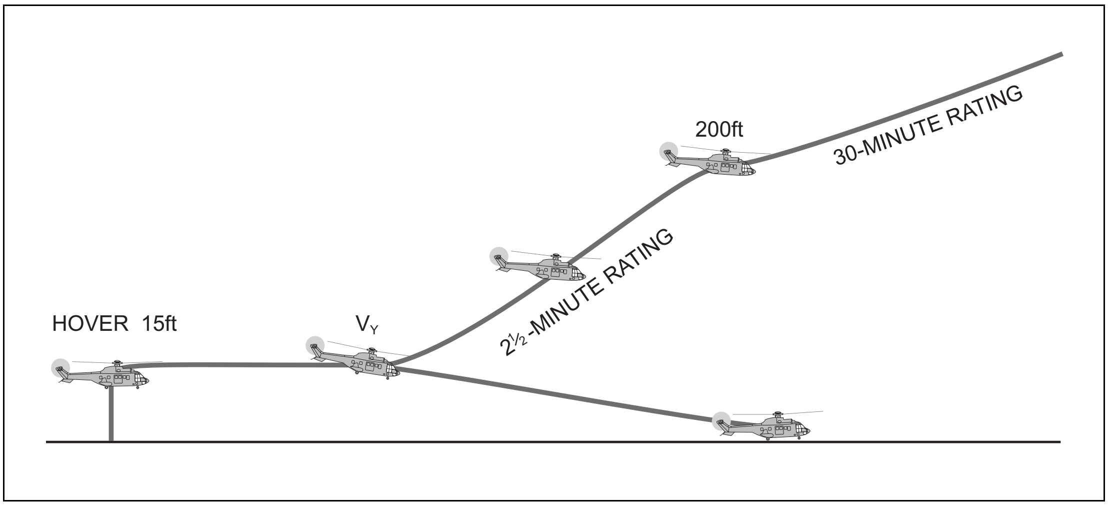


Figure 3.33 Engine Failure at Take-Off – Procedure No. 2

5.2.2.3 **Landing Procedures on Clear Airfield**

CAUTION: LANDING TO BE PERFORMED WITH NOSE WHEEL LOCKED

The following procedure permits, whenever an engine failure occurs at the LDP, either a safe landing on the ground or go-around at least 35 ft (10 m) above the landing area, followed by a single-engine climb path identical to that of the Engine Failure at Take-Off Emergency Procedure No. 1 (see page 39).

- **Normal Landing Procedure**

PILOT:
- Determines V_Y.
- Proceeds with final approach to reach LDP (h1 = 100 ft (30 m)), V_1 = 40 kt (74 km/h), and ROD = 300 to 500 fpm.

COPILOT:
- Announces arrival at the CDP.

PILOT:
- Slowly decreases speed to 30 kt (55 km/h) and reduces collective pitch to continue descent down to 15 ft approx. at 30 kt (55 km/h) IAS.
- Increases collective pitch for smooth landing.
- After contact with ground, resets cyclic pitch stick to neutral position.
- Applies brakes normally.

NOTE: During complete landing phase and from 1,000 ft above ground, switch off all equipment that uses bleed air from the engines.

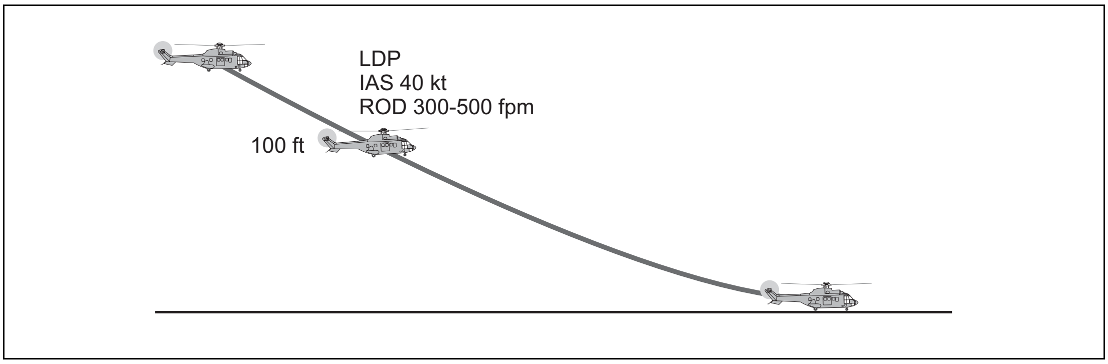


Figure 3.34 Normal Landing

- **Emergency Landing Procedures**

Engine failure before or at LDP

As the helicopter is at the maximum permissible mass (see Figure 3.29), the pilot can either:

- land; or
- hold V_{TOSS} and go around.

In the go-around case:

PILOT:
- Selects and holds NR at 245 rpm (92.5%) while holding V_{TOSS}.
- Climbs to 200 ft at V_{TOSS}.
- Accelerates in level flight to V_Y.

COPILOT:
- Announces rotor rpm.

Engine failure after LDP

Engine failure after LDP during the final approach entails IMMEDIATE LANDING. In this case proceed as follows:

PILOT:
- Continues decelerating gradually, setting an appropriate nose-up attitude.
- Holds NR above 245 rpm (92.5%) and ROD between 300 and 500 fpm.
- When near the ground, sets the helicopter in a 5° nose-up attitude which is held until wheels touch the ground.
- Increases collective pitch to cushion touchdown.
- When helicopter is on the ground, applies wheel brakes to stop forward run and decrease collective pitch while returning cyclic stick to neutral.

COPILOT:
- Announces rotor rpm during the complete manoeuvre.

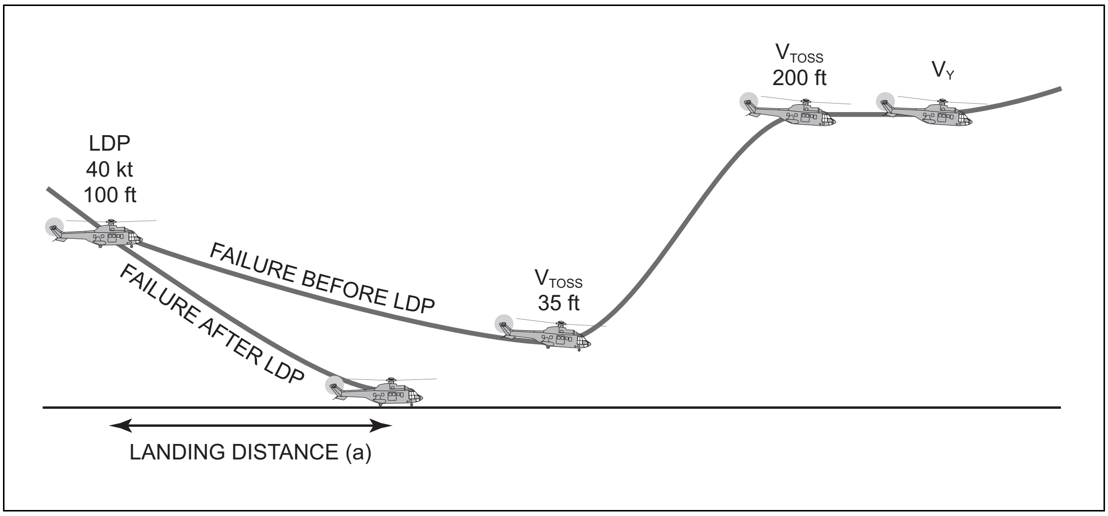


Figure 3.35 Engine Failure during Final Approach

5.2.3 **Operations on Clear Ground**

- **Take-Off Performance**

Take-off performance data on clear ground are given in the following Figures:

Procedure No. 1

• Accelerate-stop distance	Figures 3.40 and 3.41
• Distance to clear 35 ft (10 m)	Figures 3.40 and 3.41
• Distance to climb from 35 to 200 ft (10 to 60 m) at V_{TOSS} and 2½-min rating	Figure 3.42
• Accelerate distance from V_{TOSS} to V_Y at 200 ft (60 m)	Figure 3.43
• Climb gradient and distance to climb from 200 to 1,000 ft (60 to 300 m) at V_Y	Figure 3.44

Procedure No. 2

Maximum accelerate-stop distance for any mass, CG location and temperature condition is 800 m.

- Clearing 35 ft (10 m) is always possible on distances less than the runway length imposed by the accelerate-stop distance. It will therefore be equal to 1,000 m or 800 m according to the CG location.
- 2nd segment V_Y climb gradients are given in Figure 3.44 for a speed of V_Y at the 30-minute rating. No consideration is given to V_Y at the 2½-minute rating, which would produce a higher climb gradient and an increased safety clearing height.

The distance obtained from Figure 3.44 for this procedure is then multiplied by 1.2 to account for the fact that Distance D2 has been omitted.

V_{TOSS} is assumed to be the IAS and equal to 45 kt (83 km/h) for all mass, altitude and temperature configurations.

V_Y is assumed to be the IAS and equal to 70 kt (130 km/h) for all altitude configurations below 5,000 ft, with a 5 kt (9 km/h) decrease every 5,000 ft (1,525 m).

The performance calculations must show that for any take-off configuration, the mass, altitude, temperature and wind parameters combine to ensure that the:

- distances for accelerate-stop and 35 ft (10 m) clearing distance (D1) are compatible with the length of runway;
- single-engine path after take-off is compatible with the rules defining flight over possible obstacles.

If compliance with these requirements is not possible then the take-off mass must be decreased until it is possible.

- **Landing Performance**

The LDP is defined as a combination of h1 = 100 ft (30 m), V_1 = 40 kt (74 km/h) and ROD = 300 to 500 fpm.

- Whenever landing after an engine failure at the LDP, the horizontal projection of the distance necessary to reach the landing point from the LDP is considered to be constant and equal to 400 m (1,300 ft) in zero wind for any combination of mass, altitude and temperature conditions. This distance projection corresponds to a final approach gradient equal to 6%.
- In the event of go-around, after clearing 35 ft (10 m) at V_{TOSS}, the paths are identical to those used for take-off (see Figures 3.30 and 3.31).

5.2.4 Operations on Helipad

5.2.4.1 Limitations on Helipad

Apart from the particular limitations specified below, the limitations given in Section 3, paragraph 2 of this manual remain applicable.

Minimum crew (see paragraph 5.2.2.1)

Approved altitude/temperature envelope (see paragraph 5.2.2.1)

Maximum permissible masses

- The maximum take-off mass permissible on a helipad, as a function of pressure altitude and temperature, is given in Figure 3.36 (below).
- Upon final approach and landing, the maximum mass is that permissible at take-off on clear ground (see Figure 3.29).

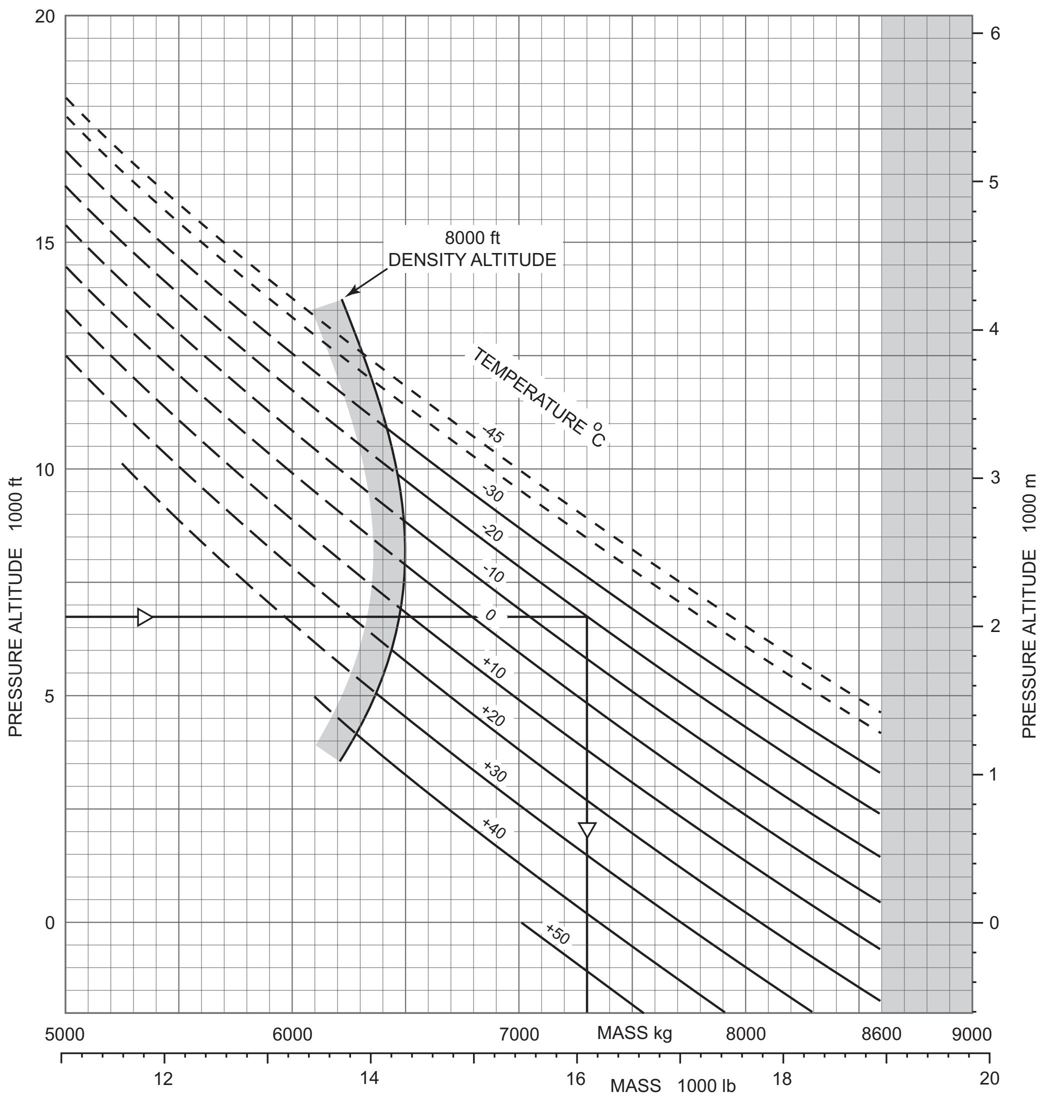


Figure 3.36 Maximum Permissible Take-Off Mass on Helipad

5.2.4.2 **Take-Off Procedures on Helipad**

CAUTION: TAKE-OFF TO BE PERFORMED WITH NOSE WHEEL LOCKED.

These procedures allow the pilot, whenever an engine fails at the CDP, either to land safely or to continue take-off, flying at least 35 ft (10 m) above the helipad and following a single-engine climb path identical to that used on clear ground in Take-Off Emergency Procedure No. 1 (see page 39).

- **Normal Take-Off Procedure from Helipad**

The take-off mass and associated V_Y must be determined before take-off. The helicopter then takes off from the final helipad threshold.

In hover flight at 15 ft (4.5 m):

PILOT: • Progressively increases pitch (without exceeding pitch or torque limit values) and slowly flies the helicopter slightly rearward up to 100 ft (30 m), while keeping the take-off area in sight just below the canopy arch member.

COPILOT: • Announces height every 20 ft (6 m) and CDP at 100 ft (30 m).

PILOT: • Tilts the helicopter so as to start forward level flight while selecting take-off rating.

COPILOT: • Announces V_{TOSS}.

PILOT: • Starts climb at V_{TOSS} while increasing speed up to V_Y.
• Selects climb parameters.

COPILOT: • Retracts landing gear at V_Y.

NOTE: During the complete take-off phase and up to 1,000 ft above ground, all equipment using bleed air (heating, air-conditioning, etc.) must be switched off.

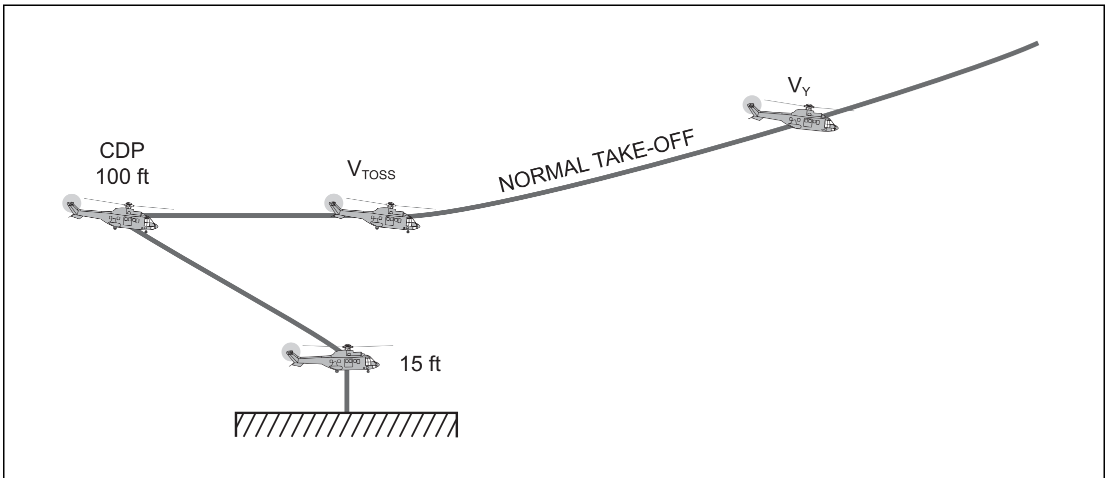


Figure 3.37 Normal Take-Off from Helipad

- **Emergency Take-Off Procedures from Helipad**

Engine Failure before CDP

Any failure of an engine before the CDP entails immediate landing, in which case:

PILOT:
- Holds NR above 245 rpm (92.5%) (14^{o} pitch approx.).
- Sets a nose-down attitude to land on the helipad. Attitude depends on height at the time of failure: 5° approx. at 35 ft (10 m), up to 18° at 100 ft (30 m).
- Sets the helicopter in landing attitude (5° max. nose-up) between 15 and 35 ft (4.5 and 10 m) and slowly increases pitch for smooth touchdown.
- Decreases collective pitch on touchdown and applies brakes to stop forward run.

COPILOT:
- Announces rpm during complete manoeuvre.

Engine failure at or after CDP

Failure of an engine at or after the CDP does not hinder take-off in forward flight.

In this configuration:

PILOT:
- Holds NR above 245 rpm (92.5%) (14° pitch approx.).
- Sets helicopter in a 15° nose-down attitude.
- Progressively decreases nose-down attitude as a function of speed increase up to V_{TOSS}, in order to minimise altitude drop.
- Climbs, at V_{TOSS}, to 200 ft (50 m) above the airfield, accelerates to V_Y at this height and continues climb at V_Y while holding 30-min rating.

COPILOT:
- Announces rpm during manoeuvre and retracts landing gear at V_Y.

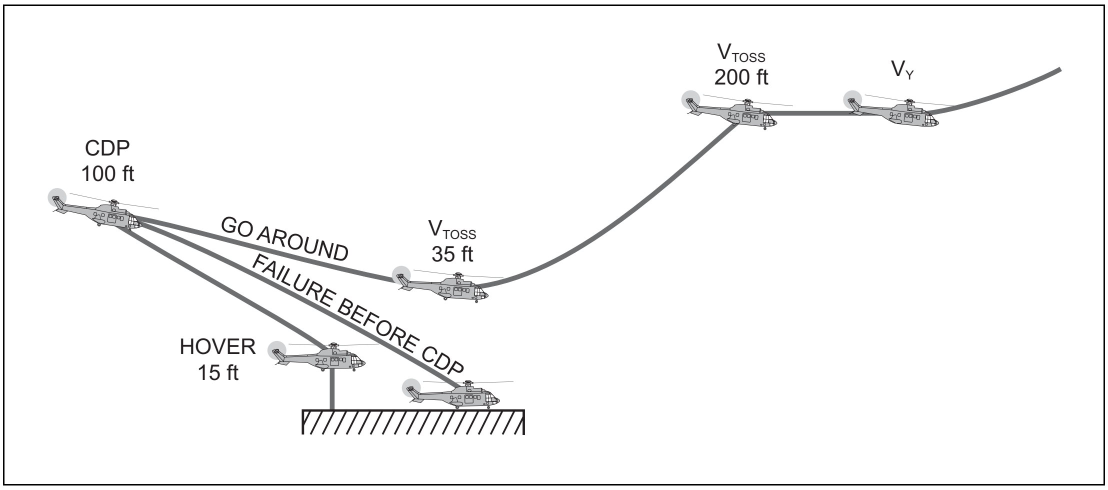


Figure 3.38 Engine Failure at Take-Off from Helipad

5.2.4.3 Landing Procedures on Helipad

CAUTION: LANDING TO BE PERFORMED WITH NOSE WHEEL LOCKED.

- **Normal Landing Procedure on Helipad**

The LDP is defined as: h1 = 100 ft (35 m), V_1 = 74 km/h and ROD = 300 to 500 fpm.

PILOT:
- Proceeds on final approach until reaching LDP.

COPILOT:
- Announces decision point.

PILOT:
- Decelerates and descends slowly (ROD = 300 to 500 fpm) down to 15 ft (4.5 m), vertical to and at zero speed with respect to helipad.
- Descends slowly and vertically, keeping helipad in view.
- Fully lowers collective pitch lever on touchdown.

NOTE: All equipment using bleed air (heating, air conditioning, etc.) must be switched off at 1,000 ft above the helipad and remain off for the complete landing phase.

- **Emergency Landing Procedure on Helipad**

Engine failure before or at LDP

Should one engine fail it is possible to go around, in which case proceed as follows:

PILOT:
- Selects NR = 245 rpm (14°-pitch approx.) and holds this speed.

COPILOT:
- Announces rotor rpm.

PILOT:
- Accelerates up to V_{TOSS}.
- Retains V_{TOSS} up to 200 ft (60 m) above helipad at NR = 245 rpm min. (92.5%)

PILOT:
- At 200 feet (60 m), accelerates in forward flight up to V_Y.

COPILOT:
- Retracts landing gear.

PILOT:
- Continues climb to V_Y while selecting 30-min rating.

Engine failure after LDP

Engine failure after LDP during final approach entails immediate landing, in which case proceed as follows:

PILOT:
- Decelerates gradually, setting an appropriate nose-up attitude.
- Holds NR above 245 rpm (92.5%) and ROD between 300 and 500 fpm to fly to the landing area at zero forward speed and to a height of 15 ft.
- Monitors vertical descent of helicopter using full travel of collective lever to cushion touchdown.
- Applies wheel brakes to stop forward movement of the helicopter and decreases collective pitch while returning cyclic stick to neutral.

COPILOT:
- Announces NRs during the complete manoeuvre.

5.2.4.4 Performance on Helipad

NOTE: The helipad minimum dimension (recommended) is 2.5 × rotor diameter i.e. approx. 37m (127 ft).

- **Take-off Performance**

Except for accelerate-stop distances, which are not applicable to helipad procedures, path performance data after clearing 35 ft (10 m) at V_{TOSS} are identical to those of Procedure No. 1 on clear ground (see paragraph 5.2.3).

- V_{TOSS} is be determined from Figure 3.41 (V_{TOSS} = 45 kt minimum).
- V_y is assumed to be equal to 70 kt IAS at altitudes below 5,000 ft (1,525 m), with a 5 kt decrease for every 5,000 ft (1,525 m) thereafter.
- The CDP shall be defined as a combination of:

  h1 = 100 ft and V_1 = 0.

As for the clear ground procedure, performance shall be computed so the that single-engine path after take-off is compatible with the rules defining flight over possible remote obstacles. If compliance with these requirements is not possible, then the take-off mass must be reduced until it is possible.

- **Landing Performance**

Performance data for landing on the helipad are identical to those procedures for landing on clear ground (see paragraph 5.2.3).

The LDP is the same as for landing on clear ground, i.e. h1 = 100 ft (30 m), V_1 = 40 kt (74 km/h), with a ROD between 300 and 500 fpm.

5.2.5 Performance Charts

Figures 3.39 to 3.44 are used to define path distances as a function of take-off mass or to determine take-off mass as a function of path distances imposed by the environment.

Figure 3.39: Take-Off Safety Speed (V_{TOSS}) Determination.

Figure 3.40: Take-Off Data Determination – Example 2a.

Figure 3.41: Take-Off Data Determination – Example 2b.

Figure 3.42: Distance D2 Determination.

Figure 3.43: Distance D3 Determination.

Figure 3.44: Distance D4 Determination.

NOTE: The performance data given in the figures are determined from the actual wind speed without the application of any correction factor.

5.2.5.1 Examples of Use of Performance Charts

Example 1 – V_{TOSS} Determination (Figure 3.39)

Assuming:

- Pressure altitude = 4,500 ft (1,370 m)
- OAT = 0°C
- Gross mass = 18,960 lb (8,600 kg), which is the maximum permissible mass on a clear airfield (see Figure 3.29).

Taking these conditions, enter the left-hand vertical axis of Figure 3.39 at 4,500 ft and follow the example. V_{TOSS} is 46 kt (85 km/h)

NOTE: If the graph path leads to a V_{TOSS} below 45 kt (general case), a V_{TOSS} of 45 kt (minimum value) shall be adopted.

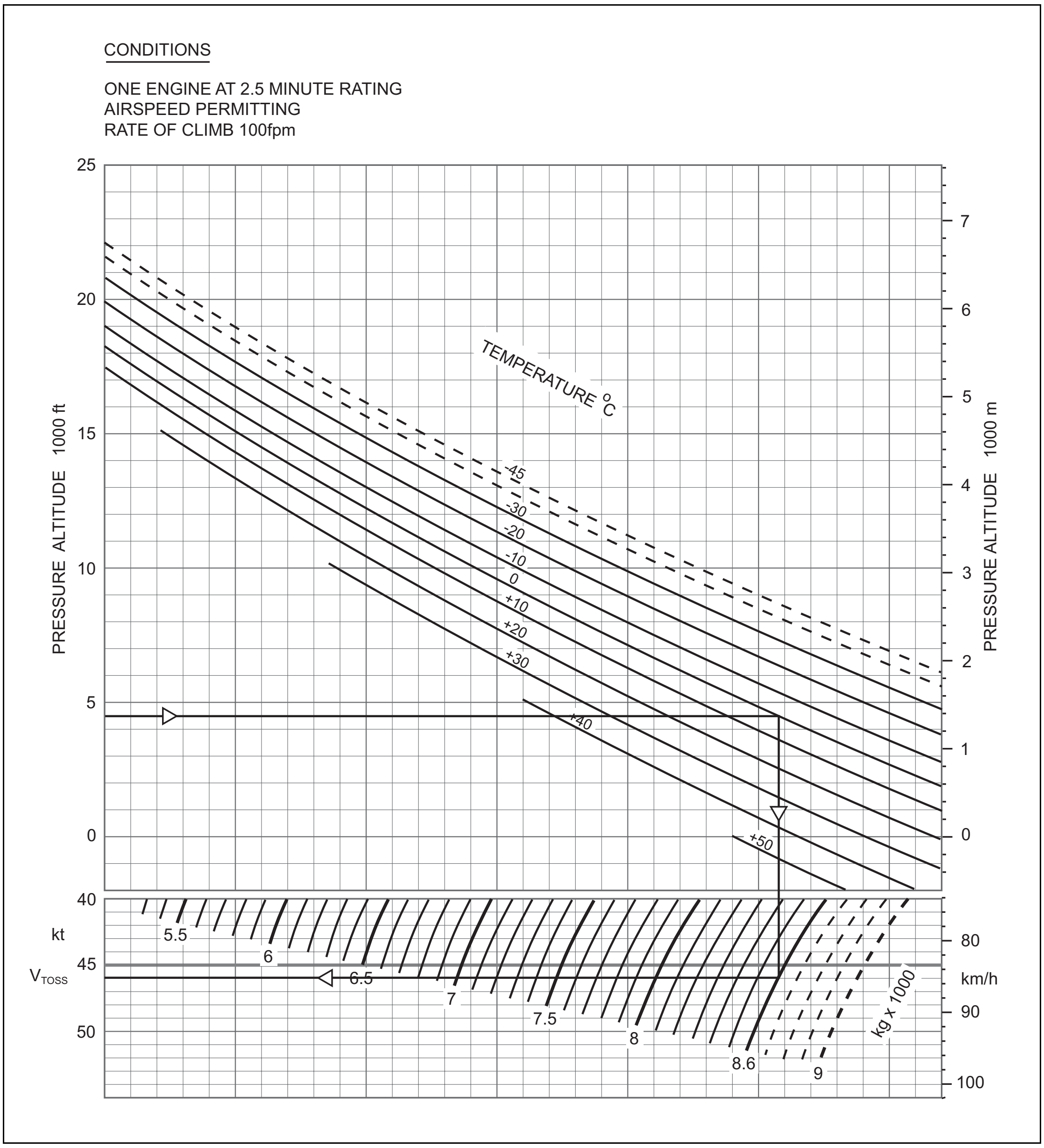


Figure 3.39 Take-Off Safety Speed (V_{TOSS}) Determination

5.2.5.2 **Example 2a – Take-off Data Determination (Figure 3.40)**

Using the following data:

OAT = +20°C
Aerodrome pressure altitude = 5,000 ft
Take-off mass = 7,500 kg
Headwind component = 20 kt

a) Enter the lower-left graph of Figure 3.40 on the right vertical axis at OAT = +20°C – see point 1.

b) Travel horizontally left to intersect the Aerodrome Pressure Altitude grid line for 5,000 ft – see point 2.

NOTE: At the intersection with the horizontal axis of the upper-left graph, the Density Altitude (6,800 ft) can be read – see point 3.

c) Continue vertically up to intersect the Take-Off Mass grid line for 7,500 kg – see point 4.

d) At this intersection, travel horizontally right to the vertical axis of the upper left graph to read the Corrected Take-Off Mass (9,200 kg) – see point 5.

e) Continue horizontally right to the centre graph, to intersect the OAT grid line for +20°C – see point 6.

f) At this point, drop vertically to intersect the Headwind component grid line for 20 kt – see point 7.

g) Move horizontally right from this point to the left vertical axis of the right-hand graph to read the Critical Time (five seconds) – see point 8.

h) Continue horizontally right to intersect the Accelerate-Stop Distance grid line (d) – see point 10.

i) Drop vertically to read the Accelerate-Stop Distance (200 m).

j) Return to point 10 and continue horizontally right to intersect the 35 ft Clearing Distance grid line (D1) – see point 11.

k) From point 11 drop vertically to read the distance taken to clear 35 ft, i.e. 290 m.

l) Return to point 7 and continue vertically down to intersect the appropriate Aerodrome Pressure Altitude grid line for 5,000 ft – see point 9.

m) Now travel horizontally left to the left vertical axis of the centre graph to read the Critical Speed (35 kt).

NOTE: If the horizontal line extension to the right of points 4 and 5 fails to intersect the OAT grid-lines then the Critical Time is four seconds, the Critical Speed is 30 kt, the Accelerate-Stop Distance (d) is 150 m and the 35 ft Clearing Distance (D1) is 270 m. The corresponding procedure is shown in Example 2b.

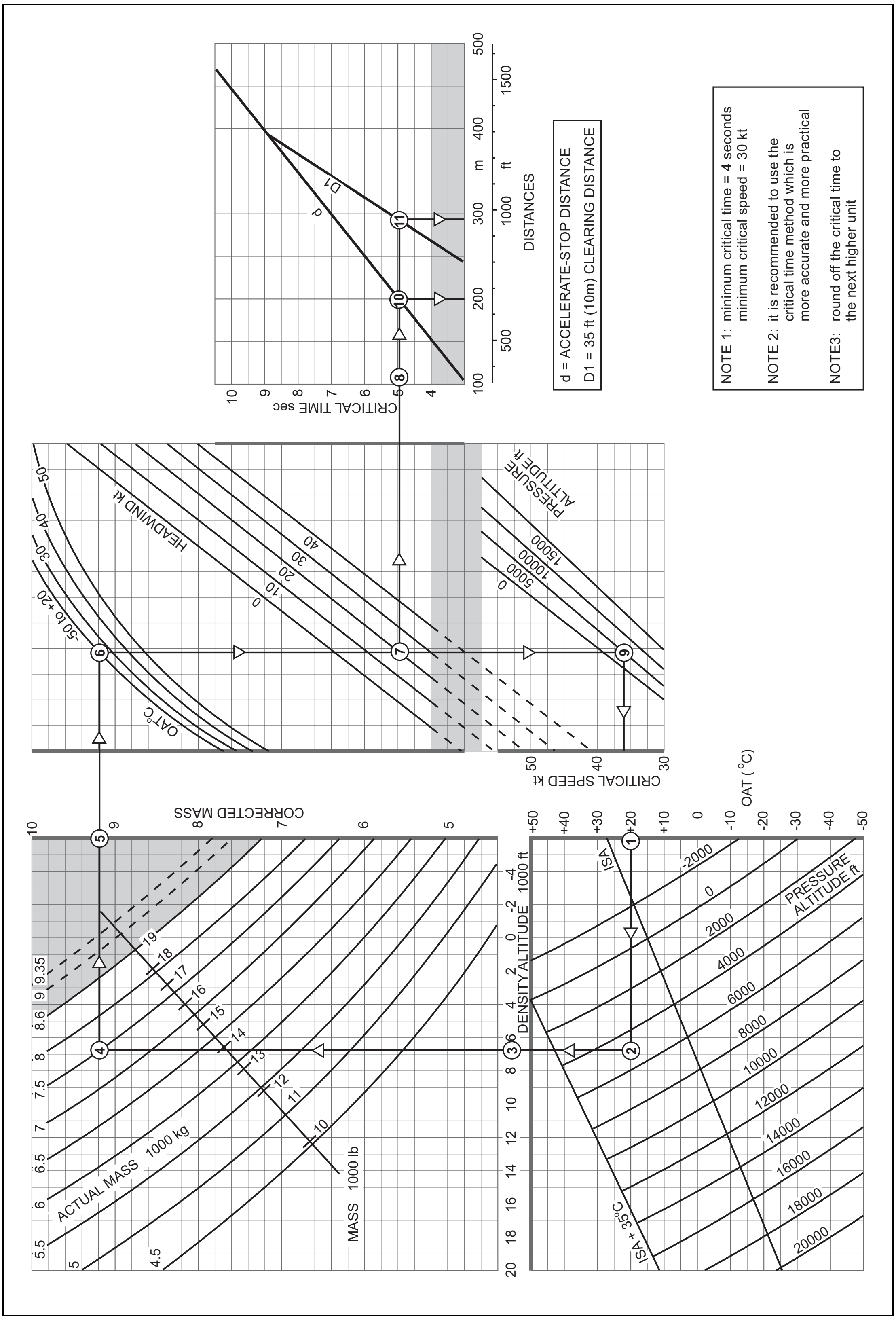


Figure 3.40 Take-Off Data Graph – Example 2a

Example 2b – Take-off Data Determination (Figure 3.41)

Using the following data:

OAT = +25°C
Aerodrome pressure altitude = 4,000 ft
Take-off mass = 5,000 kg
Headwind component = 30 kt

a) Enter the lower-left graph of Figure 3.41 on the right vertical axis at OAT = +25°C – see point A.

b) Travel horizontally left to intersect the Aerodrome Pressure Altitude grid line for 4,000 ft – see point B.

NOTE: At the intersection with the horizontal axis of the upper-left graph, the Density Altitude (6,100 ft) can be read – see point C.

c) Continue vertically up to intersect the Take-Off Mass grid line for 5,000 kg – see point D.

d) From this intersection, travel horizontally right to the vertical axis of the upper left graph to read the Corrected Take-Off Mass (6,050 kg).

e) Continue horizontally right to the centre graph. No intersection of the OAT grid lines is possible. Therefore, at the left vertical axis of the graph (shown as point E), drop vertically to the shaded portion of the graph at point F and continue horizontally right to the right-hand graph.

f) The Accelerate-Stop Distance (d) and the 35 ft Clearing Distance (D1) are determined by dropping vertical lines from the points where the shading intersects the appropriate grid line. In this example d = 150 m and D1 = 270 m.

g) Return to point F and continue vertically to the carpet of the sub-graph to read the Critical Speed (30 kt) – see point G.

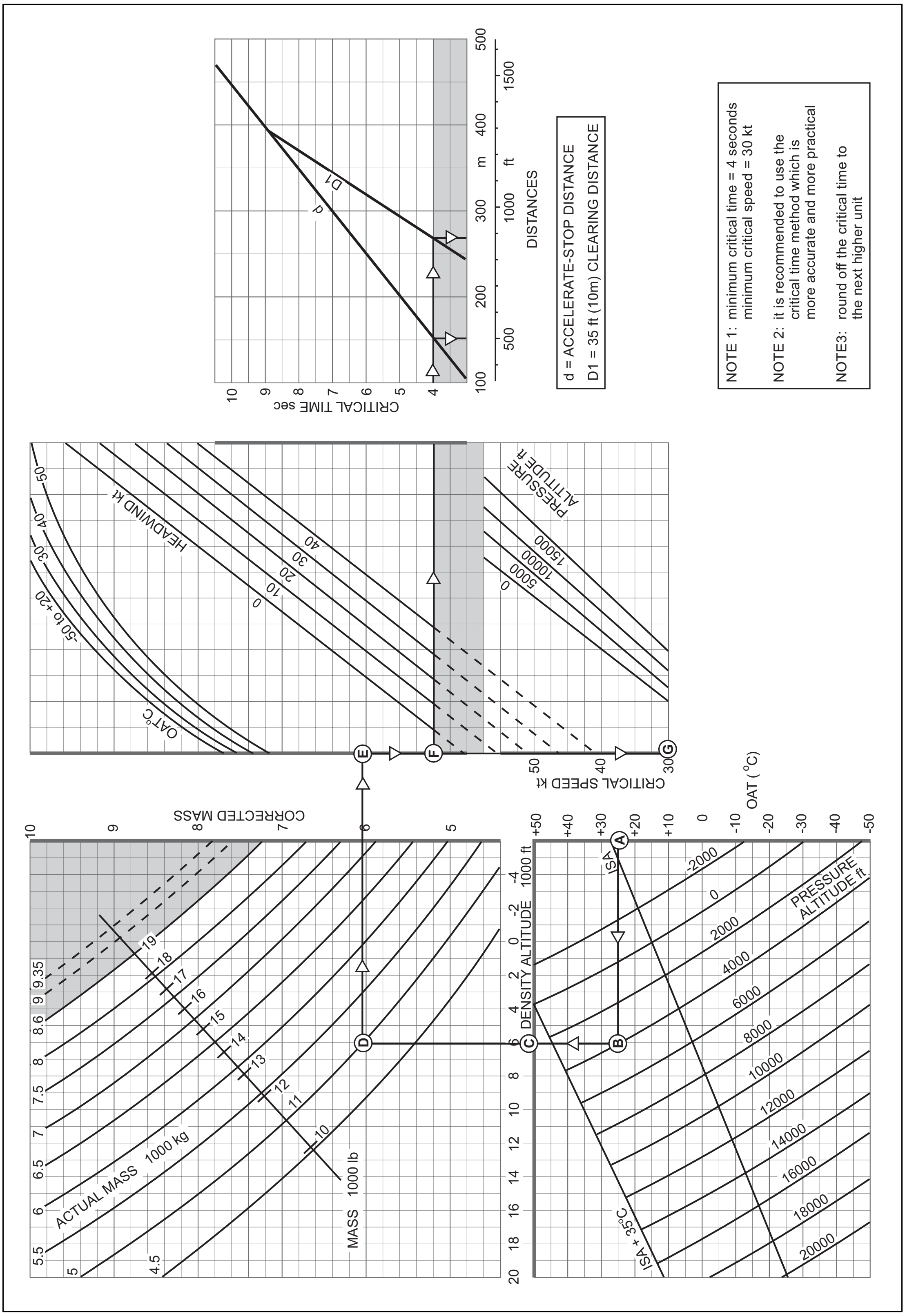


Figure 3.41 Take-Off Data Graph – Example 2b

Example 3 – Distance D2 Determination (Figure 3.42)

OAT = 0°C; Aerodrome Pressure Altitude = 6,000 ft; Take-off Mass = 7,000 kg; Headwind Component = 5 kt. Enter the horizontal axis of the upper-left graph at Pressure Altitude = 6,000 ft and follow the example line.

The resultant Distance D2 = 1,000 m (3,280 ft); Gradient = 5%.

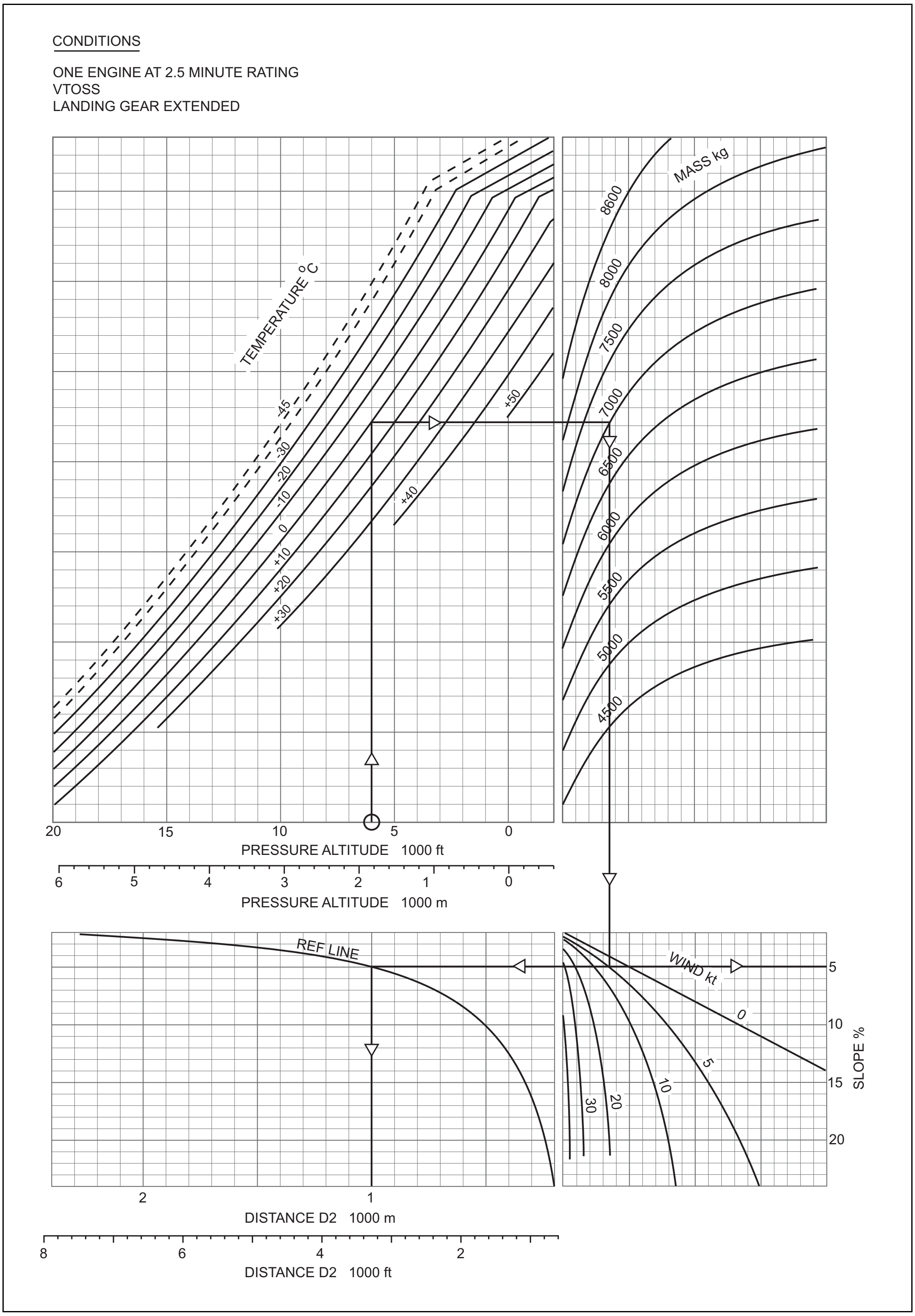


Figure 3.42 Determination of Distance D2 Required to Climb from 35 to 200 ft

Example 4 – Distance D3 Determination (Figure 3.43)

OAT = +10°C; Aerodrome Pressure Altitude = 5,000 ft; Take-off Mass = 8,000 kg; Headwind Component = 10 kt. Enter the horizontal axis of the upper-left graph at Pressure Altitude = 5,000 ft and follow the example line.

The resultant Distance D3 = 800 m (2,624 ft).

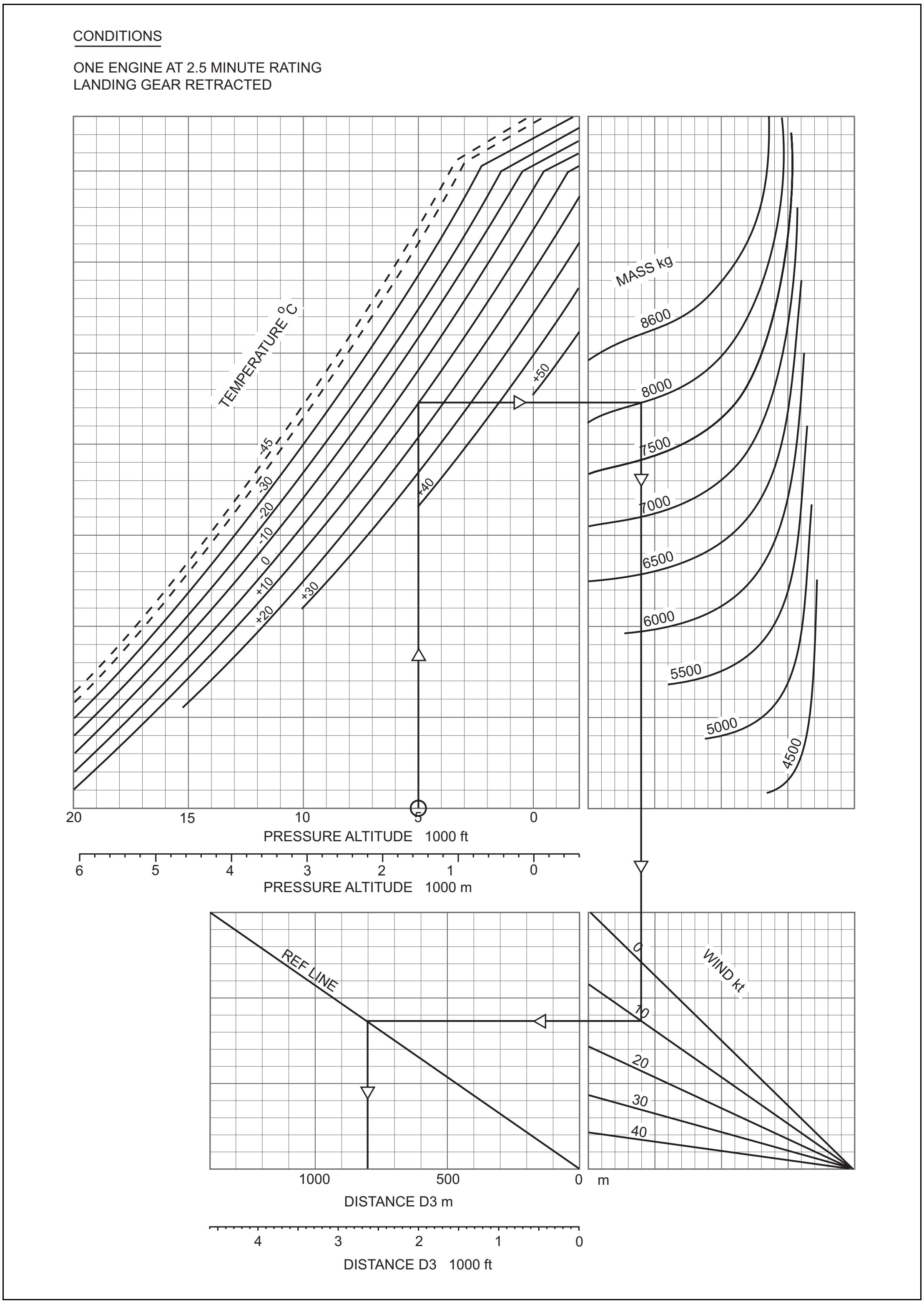


Figure 3.43 Determination of Distance D3 Required to Accelerate from V_{TOSS} to V_Y in Level Flight

Example 5 – Distance D4 Determination (Figure 3.44)

OAT = -10°C; Aerodrome Pressure Altitude = 6,000 ft; Mass = 7,000 kg; Headwind Component = 30 kt. Enter the horizontal axis of the upper-left graph at Pressure Altitude = 6,000 ft and follow the example line.

The resultant Distance D3 = 1,100 m (3,608 ft); Gradient = 22%.

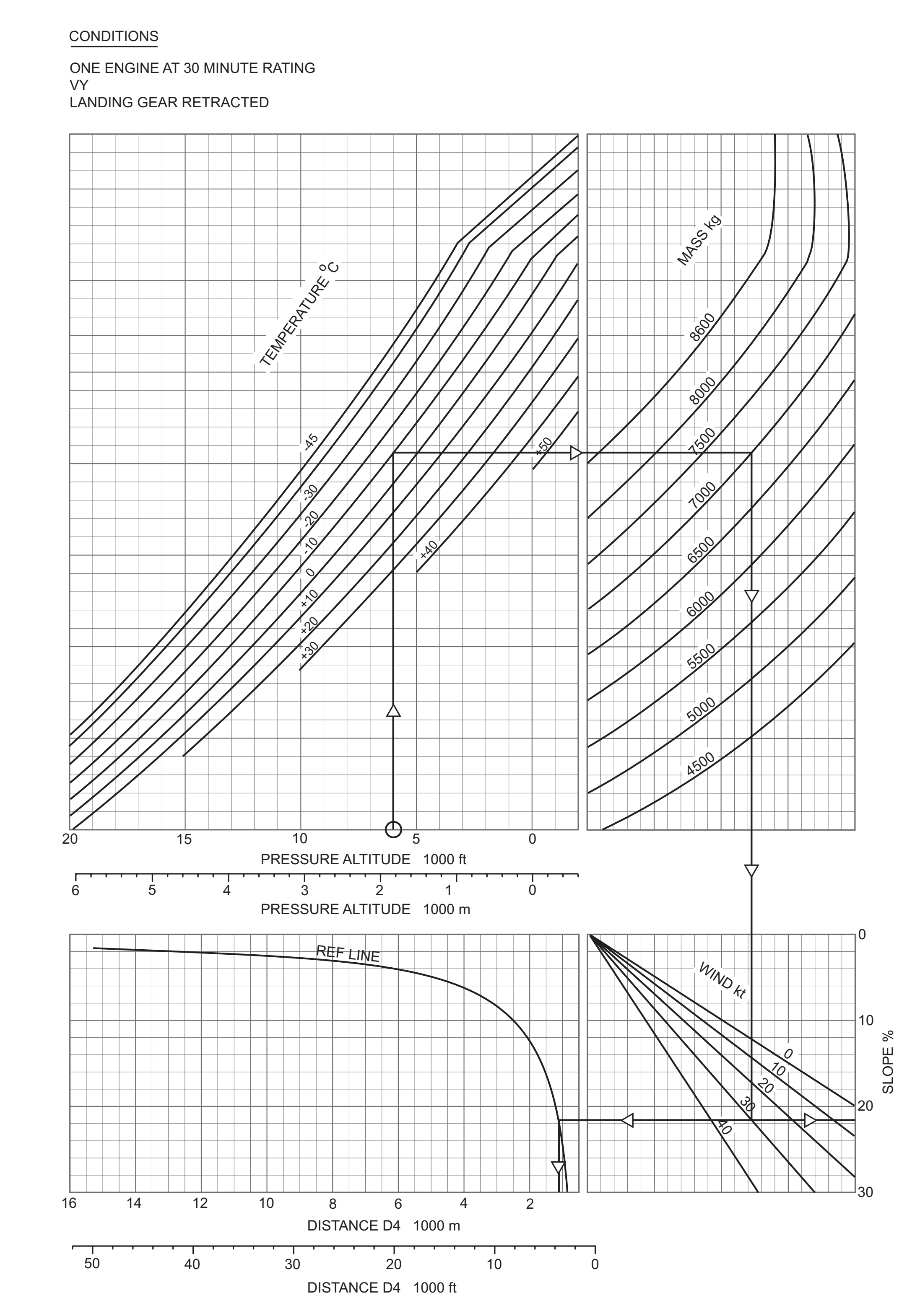


Figure 3.44 Determination of Distance D4 Required to Climb from 200 to 1,000 ft