

SECTION 5 PERFORMANCE

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INTRODUCTION

Performance data charts on the following pages are presented so that you may know what to expect from the airplane under various conditions, and also, to facilitate the planning of flights in detail and with reasonable accuracy. The data in the charts has been computed from actual flight tests with the airplane and engine in good condition and using average piloting techniques.

It should be noted that the performance information presented in the range and endurance profile charts allows for 45 minutes reserve fuel at the specified power setting. Fuel flow data for cruise is based on the recommended lean mixture setting. Some indeterminate variables such as mixture leaning technique, fuel metering characteristics, engine and propeller condition, and air turbulence may account for variations of 10% or more in range and endurance. Therefore, it is important to utilize all available information to estimate the fuel required for the particular flight.

USE OF PERFORMANCE CHARTS

Performance data is presented in tabular or graphical form to illustrate the effect of different variables. Sufficiently detailed information is provided in the tables so that conservative values can be selected and used to determine the particular performance figure with reasonable accuracy.

SAMPLE PROBLEM

The following sample flight problem utilizes information from the various charts to determine the predicted performance data for a typical flight. The following information is known:

AIRPLANE CONFIGURATION

Takeoff weight	2350 Pounds
Usable fuel	40 Gallons

TAKEOFF CONDITIONS

Field pressure altitude	1500 Feet
Temperature	28°C (16°C above standard)
Wind component along runway	12 Knot Headwind
Field length	3500 Feet

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CRUISE CONDITIONS

Total distance	320 Nautical Miles
Pressure altitude	5500 Feet
Temperature	20°C (16°C above standard)
Expected wind enroute	10 Knot Headwind

LANDING CONDITIONS

Field pressure altitude	2000 Feet
Temperature	25°C
Field length	3000 Feet

TAKEOFF

The takeoff distance chart, figure 5-4, should be consulted, keeping in mind that the distances shown are based on the short field technique. Conservative distances can be established by reading the chart at the next higher value of weight, altitude and temperature. For example, in this particular sample problem, the takeoff distance information presented for a weight of 2400 pounds, pressure altitude of 2000 feet and a temperature of 30°C should be used and results in the following:

Ground roll	1200 Feet
Total distance to clear a 50-foot obstacle	2220 Feet

These distances are well within the available takeoff field length. However, a correction for the effect of wind may be made based on Note 3 of the takeoff chart. The correction for a 12 knot headwind is:

$$\frac{12 \text{ Knots}}{9 \text{ Knots}} \times 10\% = 13\% \text{ Decrease}$$

This results in the following distances, corrected for wind:

Ground roll, zero wind	1200
Decrease in ground roll (1200 feet × 13%)	<u>156</u>
Corrected ground roll	1044 Feet

Total distance to clear a 50-foot obstacle, zero wind	2220
Decrease in total distance (2220 feet × 13%)	<u>289</u>
Corrected total distance to clear 50-foot obstacle	1931 Feet

CRUISE

The cruising altitude should be selected based on a consideration of trip length, winds aloft, and the airplane's performance. A typical cruising altitude and the expected wind enroute have been given for this sample problem. However, the power setting selection for cruise must be determined based on several considerations. These include the cruise performance characteristics presented in figure 5-7, the range profile chart presented in figure 5-8, and the endurance profile chart presented in figure 5-9.

The relationship between power and range is illustrated by the range profile chart. Considerable fuel savings and longer range result when lower power settings are used. For this sample problem, a cruise power of approximately 65% will be used.

The cruise performance chart, figure 5-7, is entered at 6000 feet altitude and 20°C above standard temperature. These values most nearly correspond to the planned altitude and expected temperature conditions. The engine speed chosen is 2500 RPM, which results in the following:

Power	66%
True airspeed	112 Knots
Cruise fuel flow	7.4 GPH

The power computer may be used to determine power and fuel consumption more accurately during the flight.

FUEL REQUIRED

The total fuel requirement for the flight may be estimated using the performance information in figures 5-6 and 5-7. For this sample problem, figure 5-6 shows that a climb from 2000 feet to 6000 feet requires 1.6 gallons of fuel. The corresponding distance during the climb is 10 nautical miles. These values are for a standard temperature and are sufficiently accurate for most flight planning purposes. However, a further correction for the effect of temperature may be made as noted on the climb chart. The approximate effect of a non-standard temperature is to increase the time, fuel, and distance by 10% for each 10°C above standard temperature, due to the lower rate of climb. In this case, assuming a temperature 16°C above standard, the correction would be:

$$\frac{16^{\circ}\text{C}}{10^{\circ}\text{C}} \times 10\% = 16\% \text{ Increase}$$

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With this factor included, the fuel estimate would be calculated as follows:

Fuel to climb, standard temperature	1.6
Increase due to non-standard temperature (1.6 × 16%)	<u>0.3</u>
Corrected fuel to climb	1.9 Gallons

Using a similar procedure for the distance to climb results in 12 nautical miles.

The resultant cruise distance is:

Total distance	320
Climb distance	<u>-12</u>
Cruise distance	308 Nautical Miles

With an expected 10 knot headwind, the ground speed for cruise is predicted to be:

$$\begin{array}{r} 112 \\ -10 \\ \hline 102 \text{ Knots} \end{array}$$

Therefore, the time required for the cruise portion of the trip is:

$$\frac{308 \text{ Nautical Miles}}{102 \text{ Knots}} = 3.0 \text{ Hours}$$

The fuel required for cruise is:

$$3.0 \text{ hours} \times 7.4 \text{ gallons/hour} = 22.2 \text{ Gallons}$$

A 45-minute reserve requires:

$$\frac{45}{60} \times 7.4 \text{ gallons/hour} = 5.6 \text{ Gallons}$$

The total estimated fuel required is as follows:

Engine start, taxi, and takeoff	1.1
Climb	1.9
Cruise	22.2
Reserve	<u>5.6</u>
Total fuel required	30.8 Gallons

Once the flight is underway, ground speed checks will provide a more accurate basis for estimating the time enroute and the corresponding fuel

required to complete the trip with ample reserve.

LANDING

A procedure similar to takeoff should be used for estimating the landing distance at the destination airport. Figure 5-10 presents landing distance information for the short field technique. The distances corresponding to 2000 feet and 30°C are as follows:

Ground roll	610 Feet
Total distance to clear a 50-foot obstacle	1390 Feet

A correction for the effect of wind may be made based on Note 2 of the landing chart using the same procedure as outlined for takeoff.

DEMONSTRATED OPERATING TEMPERATURE

Satisfactory engine cooling has been demonstrated for this airplane with an outside air temperature 23°C above standard. This is not to be considered as an operating limitation. Reference should be made to Section 2 for engine operating limitations.

AIRSPEED CALIBRATION

NORMAL STATIC SOURCE

CONDITION:
Power required for level flight or maximum rated RPM dive.

FLAPS UP													
KIAS	50	60	70	80	90	100	110	120	130	140	150	160	
KCAS	56	62	70	79	89	98	107	117	126	135	145	154	
FLAPS 10°													
KIAS	40	50	60	70	80	90	100	110	---	---	---	---	
KCAS	49	55	62	70	79	89	98	108	---	---	---	---	
FLAPS 30°													
KIAS	40	50	60	70	80	85	---	---	---	---	---	---	
KCAS	47	53	61	70	80	84	---	---	---	---	---	---	

Figure 5-1. Airspeed Calibration (Sheet 1 of 2)

AIRSPEED CALIBRATION ALTERNATE STATIC SOURCE

HEATER/VENTS AND WINDOWS CLOSED

FLAPS UP												
NORMAL KIAS	50	60	70	80	90	100	110	120	130	140	---	---
ALTERNATE KIAS	51	61	71	82	91	101	111	121	131	141	---	---
FLAPS 10°												
NORMAL KIAS	40	50	60	70	80	90	100	110	---	---	---	---
ALTERNATE KIAS	40	51	61	71	81	90	99	108	---	---	---	---
FLAPS 30°												
NORMAL KIAS	40	50	60	70	80	85	---	---	---	---	---	---
ALTERNATE KIAS	38	50	60	70	79	83	---	---	---	---	---	---

HEATER/VENTS OPEN AND WINDOWS CLOSED

FLAPS UP												
NORMAL KIAS	40	50	60	70	80	90	100	110	120	130	140	
ALTERNATE KIAS	36	48	59	70	80	89	99	108	118	128	139	
FLAPS 10°												
NORMAL KIAS	40	50	60	70	80	90	100	110	---	---	---	---
ALTERNATE KIAS	38	49	59	69	79	88	97	106	---	---	---	---
FLAPS 30°												
NORMAL KIAS	40	50	60	70	80	85	---	---	---	---	---	---
ALTERNATE KIAS	34	47	57	67	77	81	---	---	---	---	---	---

WINDOWS OPEN

FLAPS UP												
NORMAL KIAS	40	50	60	70	80	90	100	110	120	130	140	
ALTERNATE KIAS	26	43	57	70	82	93	103	113	123	133	143	
FLAPS 10°												
NORMAL KIAS	40	50	60	70	80	90	100	110	---	---	---	---
ALTERNATE KIAS	25	43	57	69	80	91	101	111	---	---	---	---
FLAPS 30°												
NORMAL KIAS	40	50	60	70	80	85	---	---	---	---	---	---
ALTERNATE KIAS	25	41	54	67	78	84	---	---	---	---	---	---

Figure 5-1. Airspeed Calibration (Sheet 2 of 2)

TEMPERATURE CONVERSION CHART

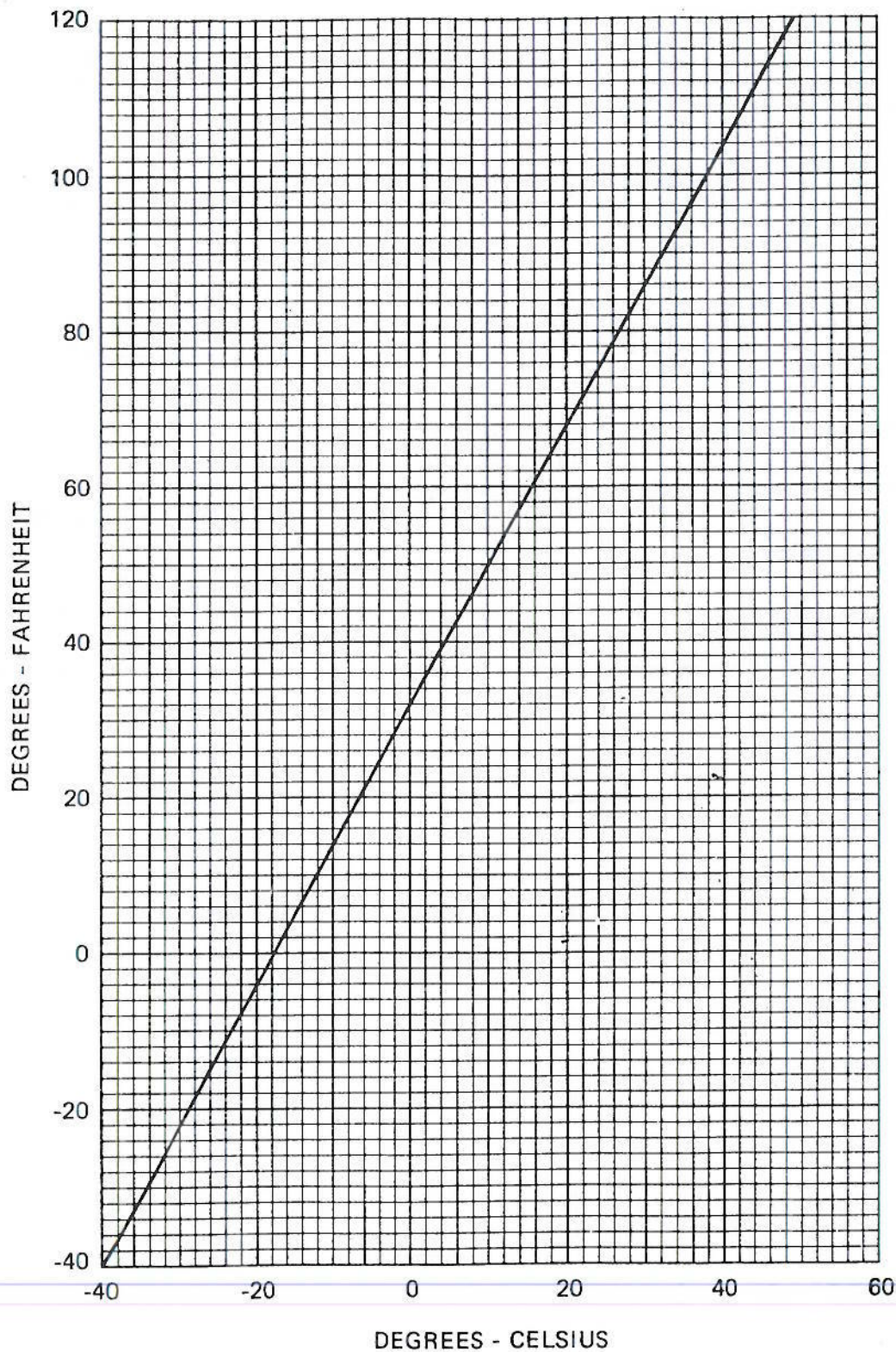


Figure 5-2. Temperature Conversion Chart

STALL SPEEDS

CONDITIONS:
Power Off

NOTES:

1. Altitude loss during a stall recovery may be as much as 230 feet.
2. KIAS values are approximate.

MOST REARWARD CENTER OF GRAVITY

WEIGHT LBS	FLAP DEFLECTION	ANGLE OF BANK							
		0°		30°		45°		60°	
		KIAS	KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS
2400	UP	44	51	47	55	52	61	62	72
	10°	35	48	38	52	42	57	49	68
	30°	33	46	35	49	39	55	47	65

MOST FORWARD CENTER OF GRAVITY

WEIGHT LBS	FLAP DEFLECTION	ANGLE OF BANK							
		0°		30°		45°		60°	
		KIAS	KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS
2400	UP	44	52	47	56	52	62	62	74
	10°	37	49	40	53	44	58	52	69
	30°	33	46	35	49	39	55	47	65

Figure 5-3. Stall Speeds

**TAKEOFF DISTANCE
MAXIMUM WEIGHT 2400 LBS**

SHORT FIELD

CONDITIONS:

- Flaps 10°
- Full Throttle Prior to Brake Release
- Paved, Level, Dry Runway
- Zero Wind

NOTES:

1. Short field technique as specified in Section 4.
2. Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full throttle, static runup.
3. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
4. For operation on a dry, grass runway, increase distances by 15% of the "ground roll" figure.

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	0°C		10°C		20°C		30°C		40°C	
	LIFT OFF	AT 50 FT		GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
2400	51	56	S.L.	795	1460	860	1570 -	925	1685	995	1810	1065	1945
			1000	875	1605	940	1725	1015	1860	1090	2000	1170	2155
				2000	1770	1035	1910	1115	2060	1200	2220	1290	2395
				3000	1960	1140	2120	1230	2295	1325	2480	1425	2685
				4000	2185	1260	2365	1355	2570	1465	2790	1575	3030
				5000	2445	1390	2660	1500	2895	1620	3160	1745	3455
				6000	2755	1540	3015	1665	3300	1800	3620	1940	3990
				7000	3140	1710	3450	1850	3805	2000	4220	- - -	- - -
				8000	3615	1905	4015	2060	4480	- - -	- - -	- - -	- - -

Figure 5-4. Takeoff Distance (Sheet 1 of 2)

**TAKEOFF DISTANCE
2200 LBS AND 2000 LBS**

SHORT FIELD

REFER TO SHEET 1 FOR APPROPRIATE CONDITIONS AND NOTES.

WEIGHT LBS	TAKEOFF SPEED KIAS		PRESS ALT FT	0°C		10°C		20°C		30°C		40°C	
	LIFT OFF	AT 50 FT		GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
2200	49	54	S.L.	650	1195	700	1280	750	1375	805	1470	865	1575
			1000	710	1310	765	1405	825	1510	885	1615	950	1735
			2000	780	1440	840	1545	905	1660	975	1785	1045	1915
			3000	855	1585	925	1705	995	1835	1070	1975	1150	2130
			4000	945	1750	1020	1890	1100	2040	1180	2200	1270	2375
			5000	1040	1945	1125	2105	1210	2275	1305	2465	1405	2665
			6000	1150	2170	1240	2355	1340	2555	1445	2775	1555	3020
			7000	1270	2440	1375	2655	1485	2890	1605	3155	1730	3450
2000	46	51	8000	1410	2760	1525	3015	1650	3305	1785	3630	1925	4005
			S.L.	525	970	565	1035	605	1110	650	1185	695	1265
			1000	570	1060	615	1135	665	1215	710	1295	765	1385
			2000	625	1160	675	1240	725	1330	780	1425	840	1525
			3000	690	1270	740	1365	800	1465	860	1570	920	1685
			4000	755	1400	815	1500	880	1615	945	1735	1015	1865
			5000	830	1545	900	1660	970	1790	1040	1925	1120	2070
			6000	920	1710	990	1845	1070	1990	1150	2145	1235	2315
7000	1015	1900	1095	2055	1180	2225	1275	2405	1370	2605			
8000	1125	2125	1215	2305	1310	2500	1410	2715	1520	2950			

Figure 5-4. Takeoff Distance (Sheet 2 of 2)

MAXIMUM RATE OF CLIMB

CONDITIONS:

Flaps Up
Full Throttle

NOTE:

Mixture leaned above 3000 feet for maximum RPM.

WEIGHT LBS	PRESS ALT FT	CLIMB SPEED KIAS	RATE OF CLIMB - FPM			
			-20°C	0°C	20°C	40°C
2400	S.L.	76	805	745	685	625
	2000	75	695	640	580	525
	4000	74	590	535	480	420
	6000	73	485	430	375	320
	8000	72	380	330	275	220
	10,000	71	275	225	175	---
	12,000	70	175	125	---	---

Figure 5-5. Maximum Rate of Climb

TIME, FUEL, AND DISTANCE TO CLIMB

MAXIMUM RATE OF CLIMB

CONDITIONS:

Flaps Up
Full Throttle
Standard Temperature

NOTES:

1. Add 1.1 gallons of fuel for engine start, taxi and takeoff allowance.
2. Mixture leaned above 3000 feet for maximum RPM.
3. Increase time, fuel and distance by 10% for each 10°C above standard temperature.
4. Distances shown are based on zero wind.

WEIGHT LBS	PRESSURE ALTITUDE FT	TEMP °C	CLIMB SPEED KIAS	RATE OF CLIMB FPM	FROM SEA LEVEL		
					TIME MIN	FUEL USED GALLONS	DISTANCE NM
2400	S.L.	15	76	700	0	0.0	0
	1000	13	76	655	1	0.3	2
	2000	11	75	610	3	0.6	4
	3000	9	75	560	5	1.0	6
	4000	7	74	515	7	1.4	9
	5000	5	74	470	9	1.7	11
	6000	3	73	425	11	2.2	14
	7000	1	72	375	14	2.6	18
	8000	-1	72	330	17	3.1	22
	9000	-3	71	285	20	3.6	26
	10,000	-5	71	240	24	4.2	32
	11,000	-7	70	190	29	4.9	38
12,000	-9	70	145	35	5.8	47	

Figure 5-6. Time, Fuel, and Distance to Climb

CRUISE PERFORMANCE

CONDITIONS:
2400 Pounds
Recommended Lean Mixture (See Section 4, Cruise)

PRESSURE ALTITUDE FT	RPM	20°C BELOW STANDARD TEMP			STANDARD TEMPERATURE			20°C ABOVE STANDARD TEMP		
		% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH
2000	2500	---	---	---	76	114	8.5	72	114	8.1
	2400	72	110	8.1	69	109	7.7	65	108	7.3
	2300	65	104	7.3	62	103	6.9	59	102	6.6
	2200	58	99	6.6	55	97	6.3	53	96	6.1
	2100	52	92	6.0	50	91	5.8	48	89	5.7
4000	2550	---	---	---	76	117	8.5	72	116	8.1
	2500	77	115	8.6	73	114	8.1	69	113	7.7
	2400	69	109	7.8	65	108	7.3	62	107	7.0
	2300	62	104	7.0	59	102	6.6	57	101	6.4
	2200	56	98	6.3	54	96	6.1	51	94	5.9
	2100	51	91	5.8	48	89	5.7	47	88	5.5
6000	2600	---	---	---	77	119	8.6	72	118	8.1
	2500	73	114	8.2	69	113	7.8	66	112	7.4
	2400	66	108	7.4	63	107	7.0	60	106	6.7
	2300	60	103	6.7	57	101	6.4	55	99	6.2
	2200	54	96	6.1	52	95	5.9	50	92	5.8
	2100	49	90	5.7	47	88	5.5	46	86	5.5
	8000	2650	---	---	---	77	121	8.6	73	120
2600	77	119	8.7	73	118	8.2	69	117	7.8	
2500	70	113	7.8	66	112	7.4	63	111	7.1	
2400	63	108	7.1	60	106	6.7	58	104	6.5	
2300	57	101	6.4	55	100	6.2	53	97	6.0	
2200	52	95	6.0	50	93	5.8	49	91	5.7	
10,000	2600	74	118	8.3	70	117	7.8	66	115	7.4
	2500	67	112	7.5	64	111	7.1	61	109	6.8
	2400	61	106	6.8	58	105	6.5	56	102	6.3
	2300	55	100	6.3	53	98	6.0	51	96	5.9
	2200	50	93	5.8	49	91	5.7	47	89	5.6
12,000	2550	67	114	7.5	64	112	7.1	61	111	6.9
	2500	64	111	7.2	61	109	6.8	59	107	6.6
	2400	59	105	6.6	56	103	6.3	54	100	6.1
	2300	53	98	6.1	51	96	5.9	50	94	5.8

Figure 5-7. Cruise Performance

RANGE PROFILE

45 MINUTES RESERVE
40 GALLONS USABLE FUEL

CONDITIONS:

2400 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature
Zero Wind

NOTE:

This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the distance during climb.

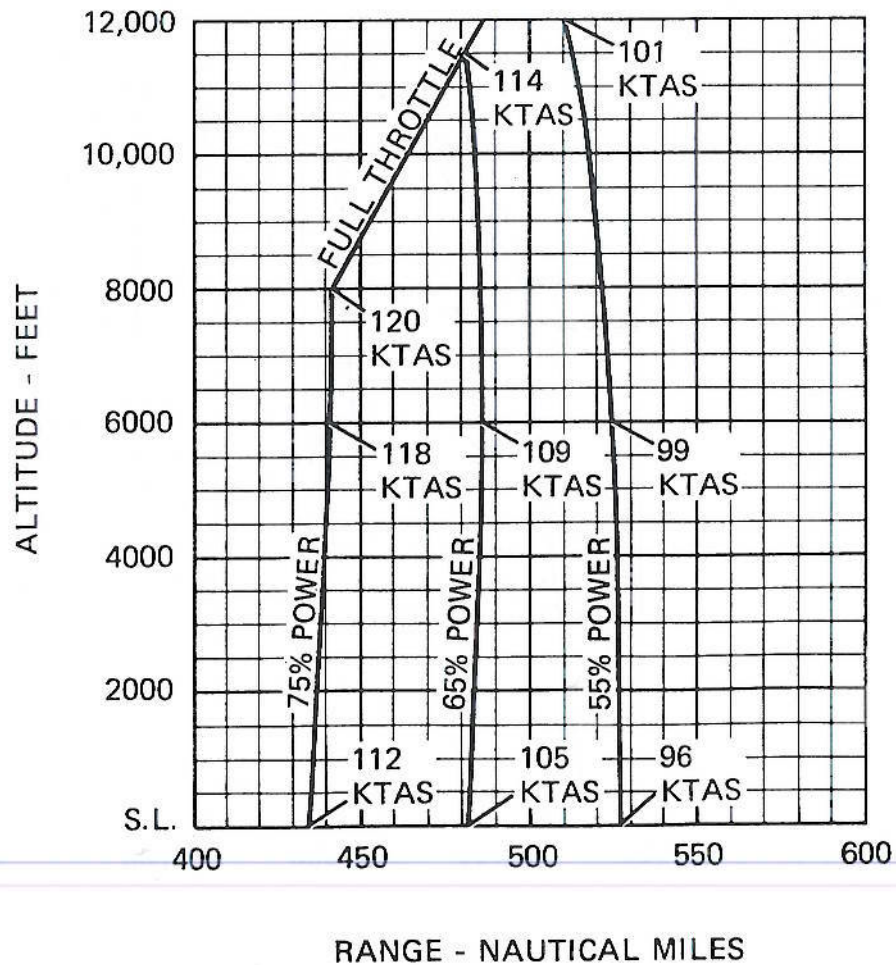


Figure 5-8. Range Profile (Sheet 1 of 3)

RANGE PROFILE

45 MINUTES RESERVE 50 GALLONS USABLE FUEL

CONDITIONS:
2400 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature
Zero Wind

NOTE:
This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the distance during climb.

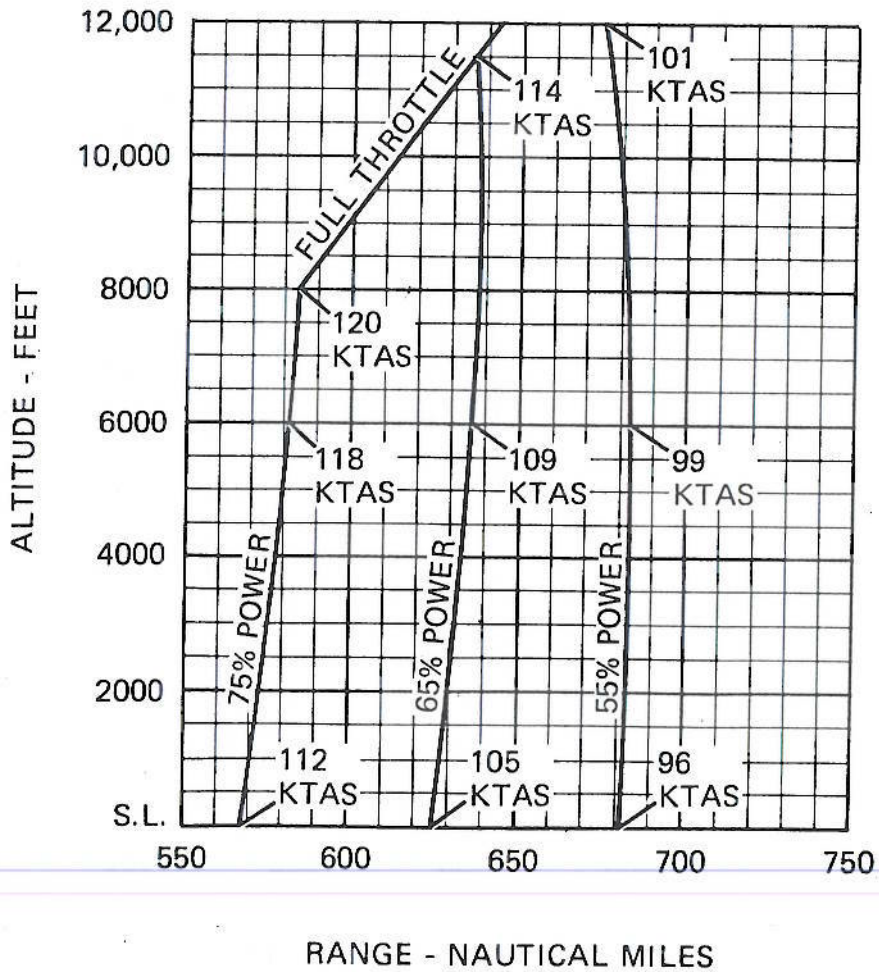


Figure 5-8. Range Profile (Sheet 2 of 3)

RANGE PROFILE 45 MINUTES RESERVE 62 GALLONS USABLE FUEL

CONDITIONS:
2400 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature
Zero Wind

NOTE:
This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the distance during climb.

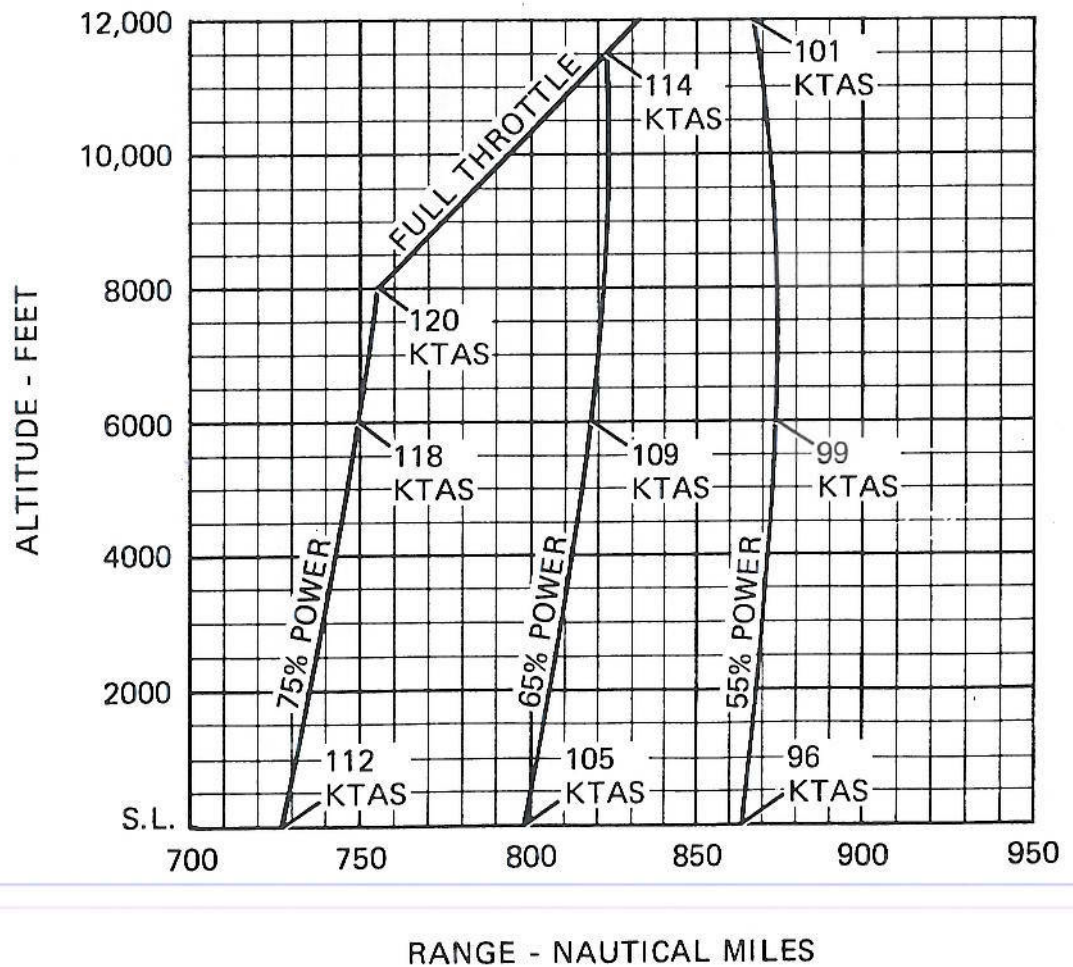


Figure 5-8. Range Profile (Sheet 3 of 3)

ENDURANCE PROFILE

45 MINUTES RESERVE
40 GALLONS USABLE FUEL

CONDITIONS:
2400 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature

NOTE:
This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the time during climb.

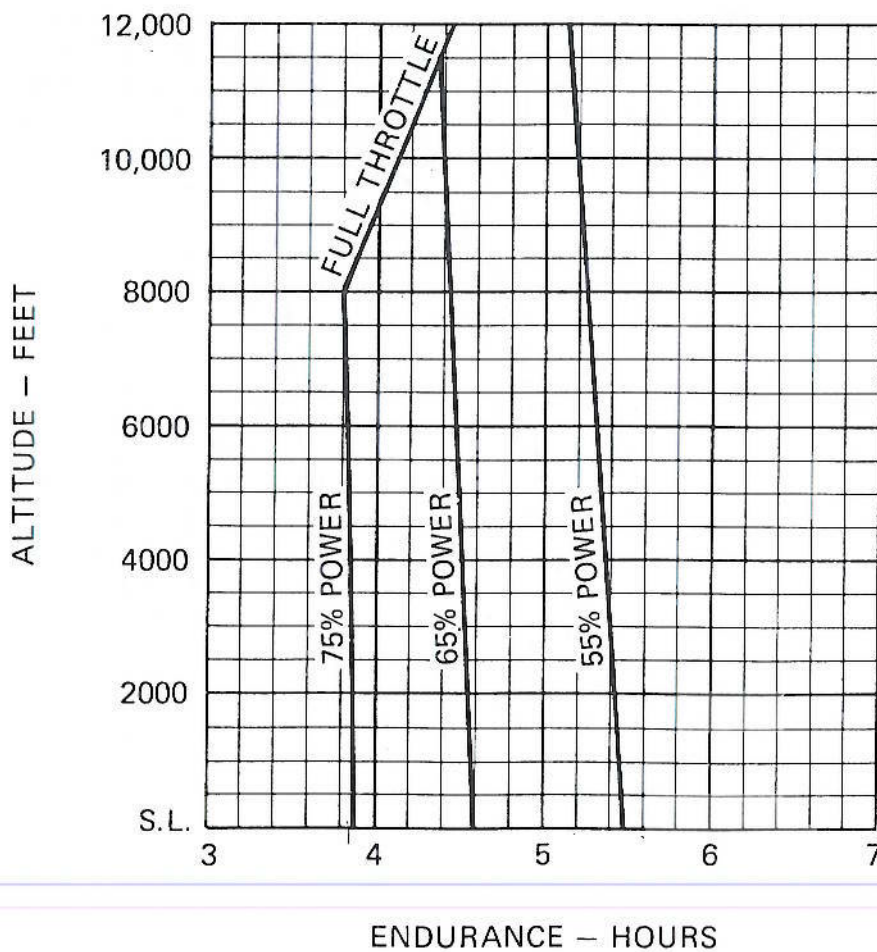


Figure 5-9. Endurance Profile (Sheet 1 of 3)

ENDURANCE PROFILE 45 MINUTES RESERVE 50 GALLONS USABLE FUEL

CONDITIONS:
2400 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature

NOTE:
This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the time during climb.

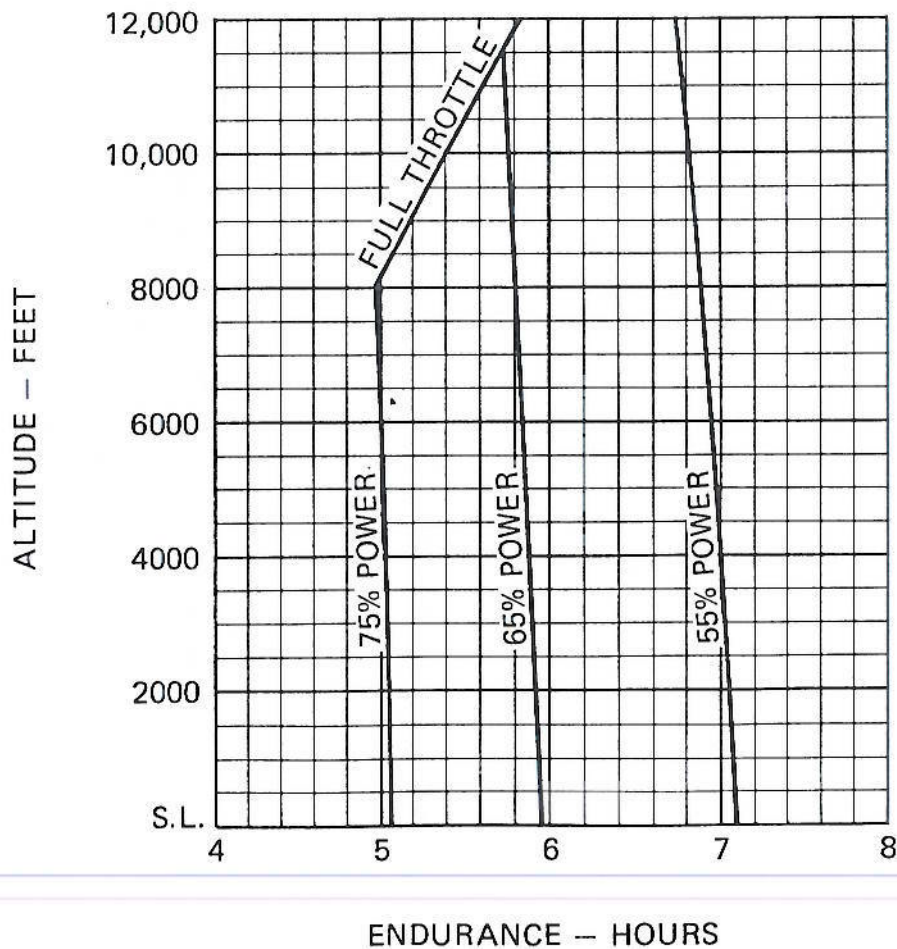


Figure 5-9. Endurance Profile (Sheet 2 of 3)

ENDURANCE PROFILE

45 MINUTES RESERVE
62 GALLONS USABLE FUEL

CONDITIONS:
2400 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature

NOTE:
This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the time during climb.

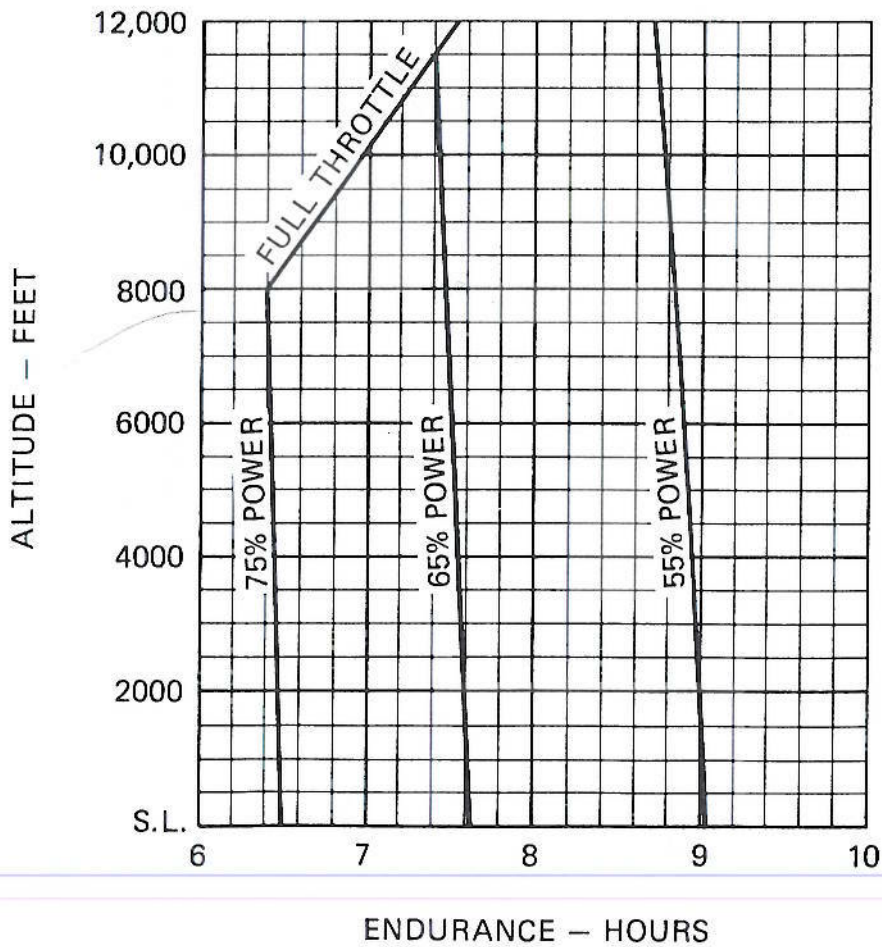


Figure 5-9. Endurance Profile (Sheet 3 of 3)

LANDING DISTANCE

SHORT FIELD

CONDITIONS:

Flaps 30°
Power Off
Maximum Braking
Paved, Level, Dry Runway
Zero Wind

NOTES:

1. Short field technique as specified in Section 4.
2. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots
3. For operation on a dry, grass runway, increase distances by 45% of the "ground roll" figure.

WEIGHT LBS	SPEED AT 50 FT KIAS	PRESS ALT FT	0°C		10°C		20°C		30°C		40°C	
			GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
2400	61	S.L.	510	1235	530	1265	550	1295	570	1325	585	1350
		1000	530	1265	550	1295	570	1325	590	1360	610	1390
		2000	550	1295	570	1330	590	1360	610	1390	630	1425
		3000	570	1330	590	1360	615	1395	635	1430	655	1460
		4000	595	1365	615	1400	635	1430	660	1470	680	1500
		5000	615	1400	640	1435	660	1470	685	1510	705	1540
		6000	640	1435	660	1470	685	1510	710	1550	730	1580
		7000	665	1475	690	1515	710	1550	735	1590	760	1630
8000	690	1515	715	1555	740	1595	765	1635	790	1675		

Figure 5-10. Landing Distance

