TABLE OF CONTENTS

SECTION 5

PERFORMANCE

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SECTION 5

PERFORMANCE

5.1 GENERAL

All of the required (FAA regulations) and complementary performance information applicable to this aircraft is provided in this section.

Performance information associated with those optional systems and equipment which require handbook supplements is provided in Section 9 (Supplements).

5.3 INTRODUCTION - PERFORMANCE AND FLIGHT PLANNING

The performance information presented in this section is based on measured flight test data corrected to I.C.A.O. standard day conditions and analytically expanded for the various parameters of weight, altitude, temperature, etc.

The performance charts are unfactored and do not make allowance for varying degrees of pilot proficiency or mechanical deterioration of the aircraft. This performance, however, can be duplicated by following the stated procedures in a properly maintained airplane.

Effects of conditions not considered on the charts must be evaluated by the pilot, such as the effect of soft or grass runway surface on takeoff and landing performance, or the effect of winds aloft on cruise and range performance. Endurance can be grossly affected by improper leaning procedures, and inflight fuel flow and quantity checks are recommended.

5.3 INTRODUCTION - PERFORMANCE AND FLIGHT PLANNING (continued)

Paragraph 5.5 (Flight Planning Example) outlines a detailed, example flight plan, using the performance charts in this section. Each chart includes its own example to show how it is used.

WARNING

Performance should not be extrapolated beyond the limits shown on the charts.

5.5 FLIGHT PLANNING EXAMPLE

(a) Aircraft Loading

The first step in planning a flight is to calculate the airplane weight and center of gravity by utilizing the information provided by Section 6 (Weight and Balance) of this handbook.

The basic empty weight for the airplane as delivered from the factory is entered in Figure 6-5. Any alterations to the airplane which affect weight and balance, should be recorded in the aircraft logbook and Weight and Balance Record (Figure 6-7). These alterations should be considered when determining the current basic empty weight of the airplane.

The Weight and Balance Loading Form (Figure 6-11) and the C.G. Range and Weight graph (Figure 6-15) may be utilized to determine the total weight of the airplane and the center of gravity position.

The following weights have been used in the flight planning example.

(1)	Basic Empty Weight	2589 lb
(2)	Occupants (2 x 170 lb)	340 lb
(3)	Baggage and Cargo	21 lb
(4)	Fuel (6 lb./gal. x 80)	480 lb
(5)	Takeoff Weight (3800 lb. max. allowable)	3430 lb
(6)	Landing Weight* (a)(5) minus (g)(1), (3430 lb minus 323 lb)	3107 lb

* Fuel used must be established (refer to item (g)(1)) before the landing weight can be calculated.

The calculated takeoff and landing weights are below the maximum limits, and the weight and balance calculations show the C.G. position within the approved limits.

(b) Takeoff and Landing

Once the aircraft loading has been determined, all aspects of the takeoff and landing must be considered.

5.5 FLIGHT PLANNING EXAMPLE (continued)

The existing conditions at the departure airport and the forecast conditions at the destination airport must be acquired and evaluated. Actual, versus forecast conditions at the destination airport should be monitored throughout the flight.

Apply the departure airport conditions and takeoff weight to the appropriate takeoff performance graphs (Figures 5-11, 5-13 and 5-15) to determine the necessary runway length for takeoff and/obstacle clearance.

Calculate the landing distance using the existing conditions at the destination airport and, when established, the landing weight.

The conditions and calculations for the example flight are listed below.

	Departure Airport	Destination Airport
(1) Pressure Altitude	1250 ft.	680 ft.
(2) Temperature	8°C	8°C
(3) Wind Component (Headwind)	6 KTS	5 KTS
(4) Runway Length Available	7400 ft.	9000 ft.
(5) Runway Required (Short Field Effort)		
Takeoff	1520 ft.*	
Landing		1238 ft.**

NOTE

The remainder of the performance charts used in this flight plan example assume a no wind condition. The effect of winds aloft must be considered by the pilot when computing climb, cruise and descent performance.

*reference Figure 5-15

**reference Figure 5-35

5.5 FLIGHT PLANNING EXAMPLE (continued)

(c) Climb

The next step in the flight plan is to determine the necessary climb segment components.

First determine the Fuel, Time and Distance to Climb from sea level to the desired cruise altitude and OAT. Then determine the Fuel, Time and Distance to Climb from sea level to the departure field pressure altitude and OAT. Subtract the departure field values from the cruise values to get the true Time, Fuel and Distance to Climb for the flight. See the following example (reference Figure 5-23):

The following values were determined from the above instructions in the flight planning example.

(1) Cruise Pressure Altitude	5500 ft.
(2) Cruise OAT	-2°C
(3) Fuel to Climb (2.6 gal. minus 0.4 gal.)	2.2 gal.*
(4) Time to Climb (4.5 min. minus 0.9 min.)	3.6 min.*
(5) Distance to Climb (7.3 naut. miles minus 1.4 naut. miles)	5.9 naut. miles*

*reference Figure 5-23

5.5 FLIGHT PLANNING EXAMPLE (continued)

(d) Descent

Determine true descent time, fuel and distance similar to the method used for climb.

First determine the Fuel, Time and Distance to Descend from cruise altitude and OAT to sea level. Then determine the Fuel, Time and Distance to Descend from the destination field altitude and OAT to sea level. Then subtract the destination field values from the cruise values to get the true Time, Fuel and Distance to Descend for the flight. See the following example (reference Figure 5-33):

The values obtained by proper utilization of the graphs for the descent segment of the example are shown below.

(1) Fuel to Descend (3 gal. minus 1 gal.)	2 gal.*
(2) Time to Descend (9 min. minus 2 min.)	7 min.*
(3) Distance to Descend (30 naut. miles minus 4 naut. miles)	26 naut. miles*

*reference Figure 5-33

5.5 FLIGHT PLANNING EXAMPLE (continued)

(e) Cruise

Starting with the total flight distance, subtract the previously determined distance to climb and distance to descend to obtain the total cruise distance. Refer to the appropriate Lycoming Operator's Manual and the Fuel and Power Setting Tables when selecting the cruise power setting. The established pressure altitude and temperature values and the selected cruise power should now be utilized to determine the true airspeed from the Speed Power graph (Figure 5-27).

Calculate the cruise fuel for the cruise power setting from the information provided on Figure 5-27.

The cruise time is found by dividing the cruise distance by the cruise speed and the cruise fuel is found by multiplying the cruise fuel flow by the cruise time.

The cruise calculations established for the cruise segment of the flight planning example are as follows:

(1) Total Distance	431 miles
(2) Cruise Distance (e)(1) minus (c)(5) minus (d)(3), (431 naut. miles minus 5.9 naut. miles minus 26 naut. miles)	399 naut. miles
(3) Cruise Power (Performance Cruise Mixture)	55% rated power
(4) Cruise Speed	140 KTS TAS*
(5) Cruise Fuel Consumption	17.4 GPH*
(6) Cruise Time (e)(2) divided by (e)(4), (399 naut. miles divided by 140 KTS)	2.85 hrs.
(7) Cruise Fuel (e)(5) multiplied by (e)(6), (17.4 GPH multiplied by 2.85 hrs.)	49.6 gal.

*reference Figure 5-27

5.5 FLIGHT PLANNING EXAMPLE (continued)

(f) Total Flight Time

The total flight time is determined by adding the time to climb, the time to descend and the cruise time. Keep in mind that the time values obtained from the climb and descent graphs are in minutes and must be converted to hours before adding them to the cruise time.

The following flight time is required for the flight planning example.

(1) Total Flight Time (c)(4) plus (d)(2) plus (e)(6), (0.06 hrs. plus 0.12 hrs. plus 2.85 hrs.)	3.03 hrs.

(g) Total Fuel Required

Determine the total fuel required by adding the fuel to climb, the fuel to descend and the cruise fuel. When the total fuel (in gallons) is determined, multiply this value by 6 lb./ gal. to determine the total fuel weight used for the flight.

The total fuel calculations for the example flight plan are shown below.

(1) Total Fuel Required (c)(3) plus (d)(1) plus (e)(7), (2.2 gal. plus 2 gal. plus 49.6 gal.)	53.8 gal
(53.8 gal. multiplied by 6 lb./gal.)	323 lb

5.7 PERFORMANCE GRAPHS

LIST OF FIGURES

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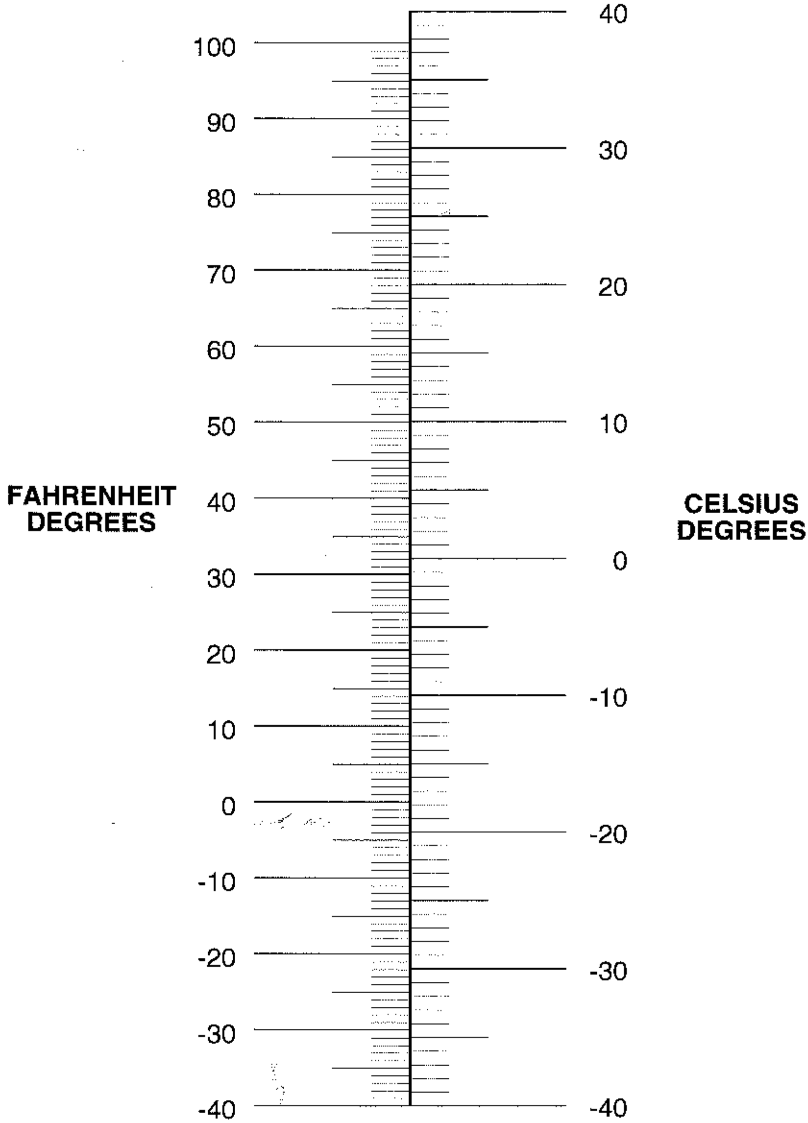
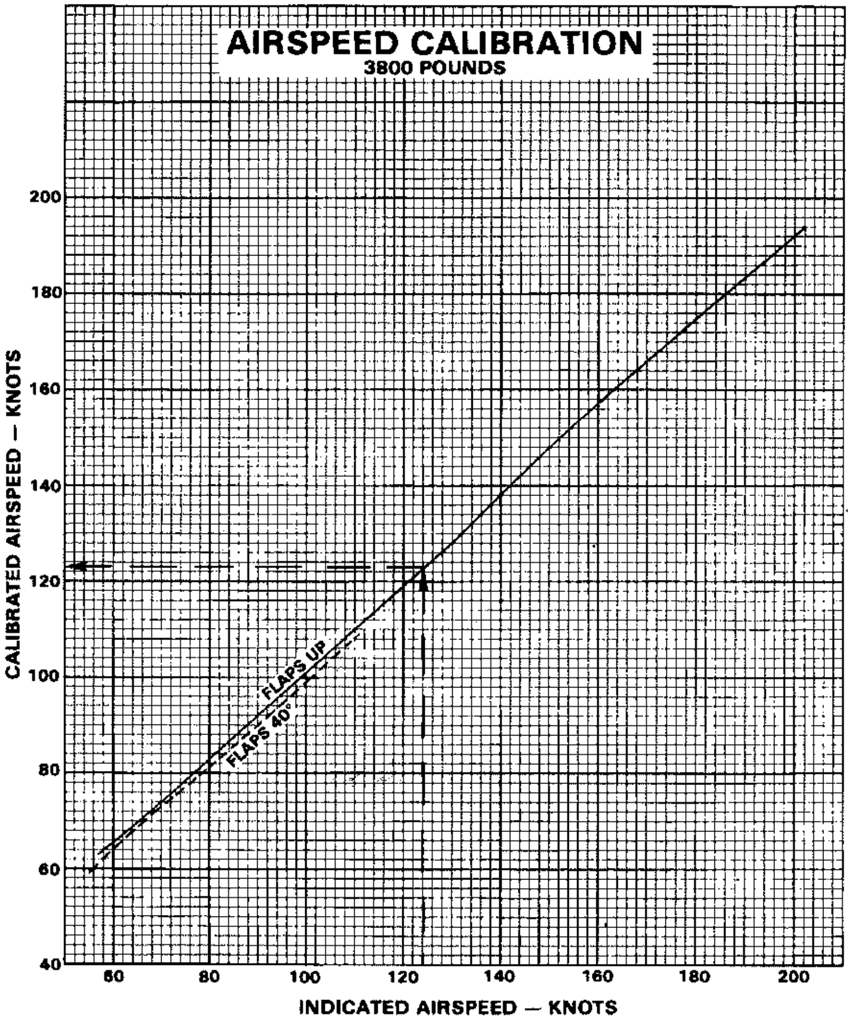
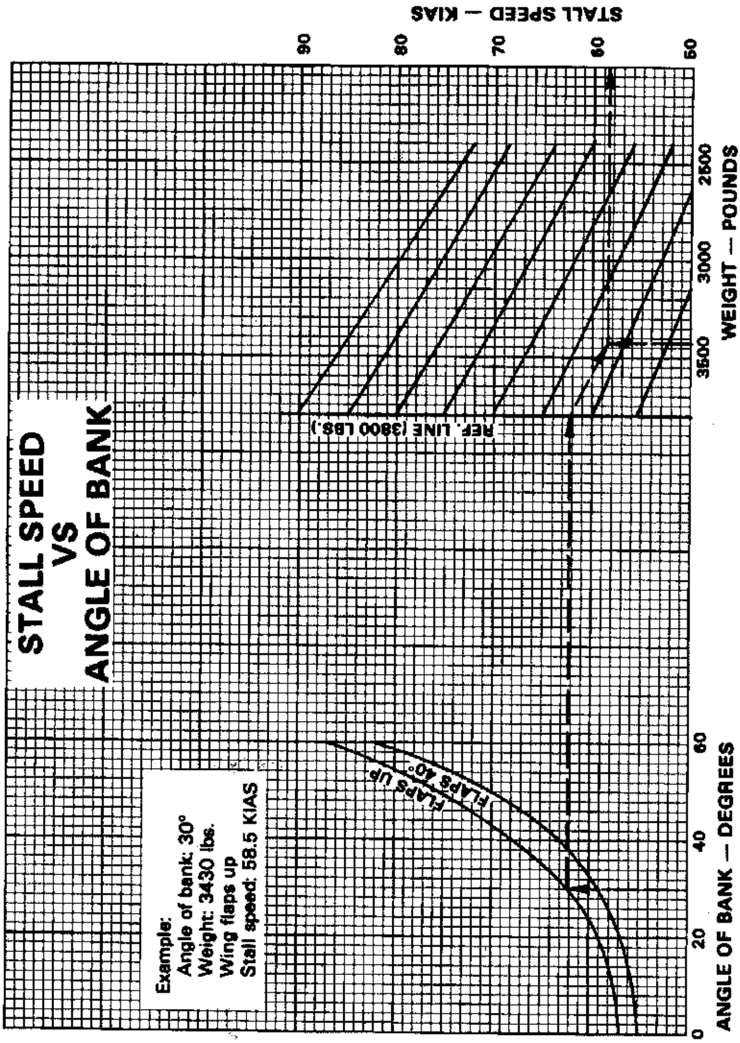


Temperature Conversion
Figure 5-1

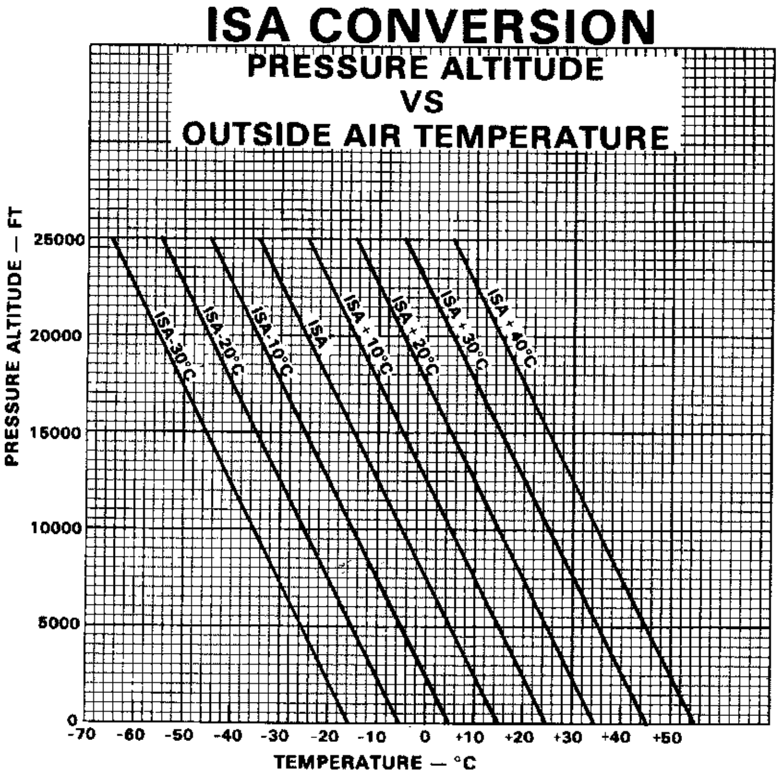


Example:
Indicated airspeed: 124 knots
Flaps up
Calibrated airspeed: 123 knots

Airspeed Calibration
Figure 5-3



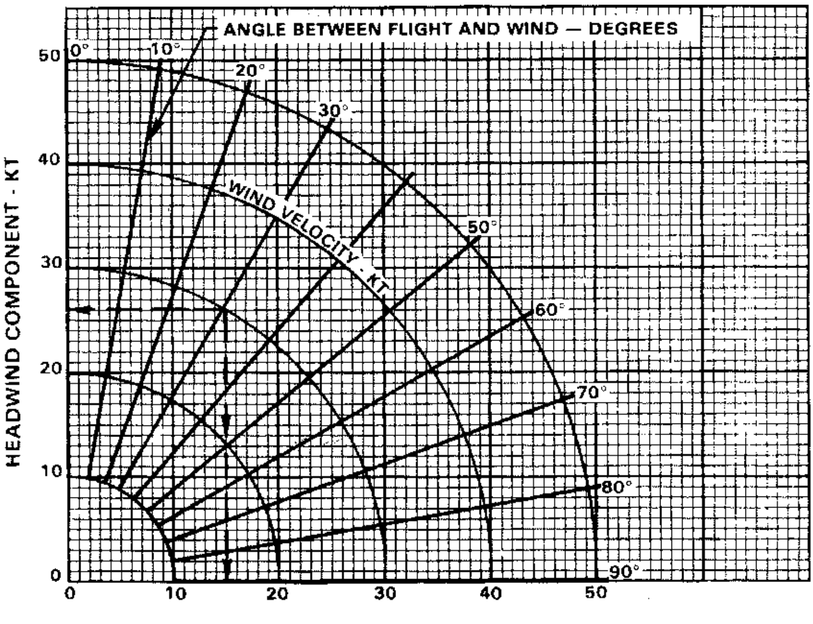
Stall Speed Vs. Angle of Bank
Figure 5-5



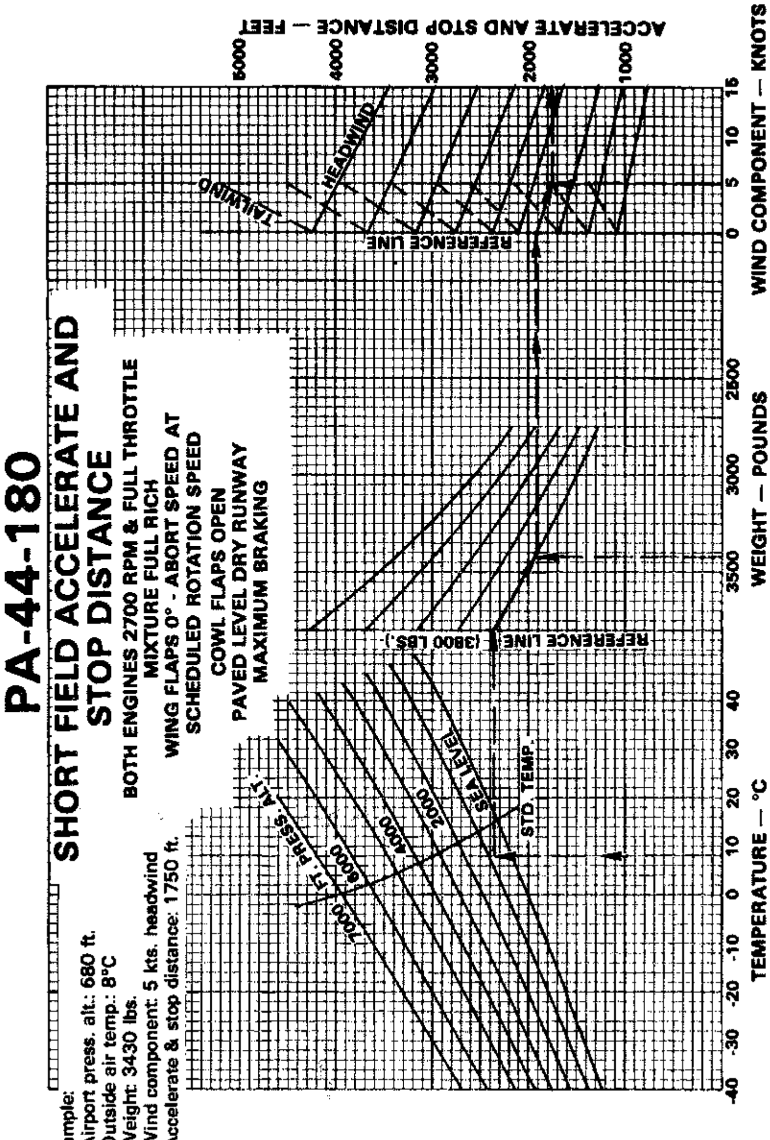
ISA Conversion
Figure 5-7

WIND COMPONENTS

Example:
Wind velocity: 30 KT
Angle between flight path and wind: 30°
Headwind: 26 KT
Crosswind component: 15 KT

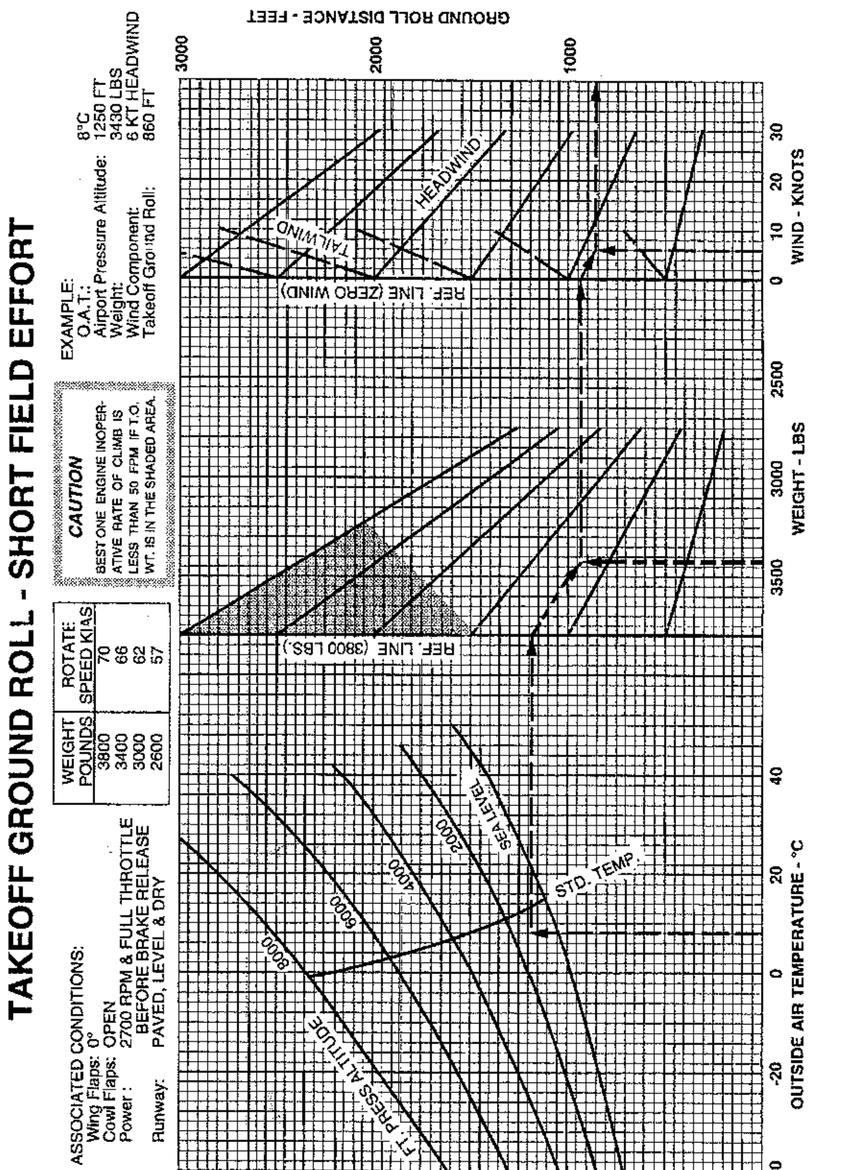


Wind Components
Figure 5-9



Accelerate And Stop Distance - Short Field Effort

Figure 5-11



Takeoff Ground Roll - Short Field Effort
Figure 5-13

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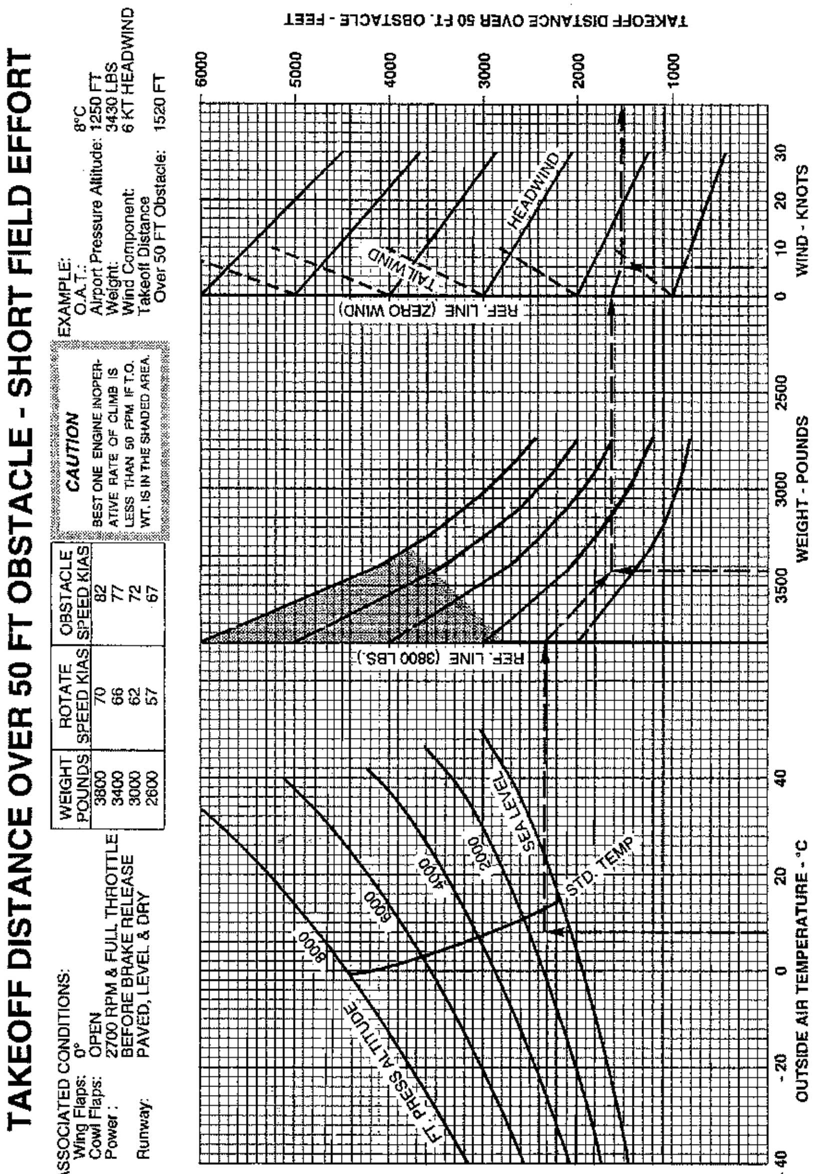

Takeoff Distance Over 50 Ft. Obstacle - Short Field Effort
Figure 5-15

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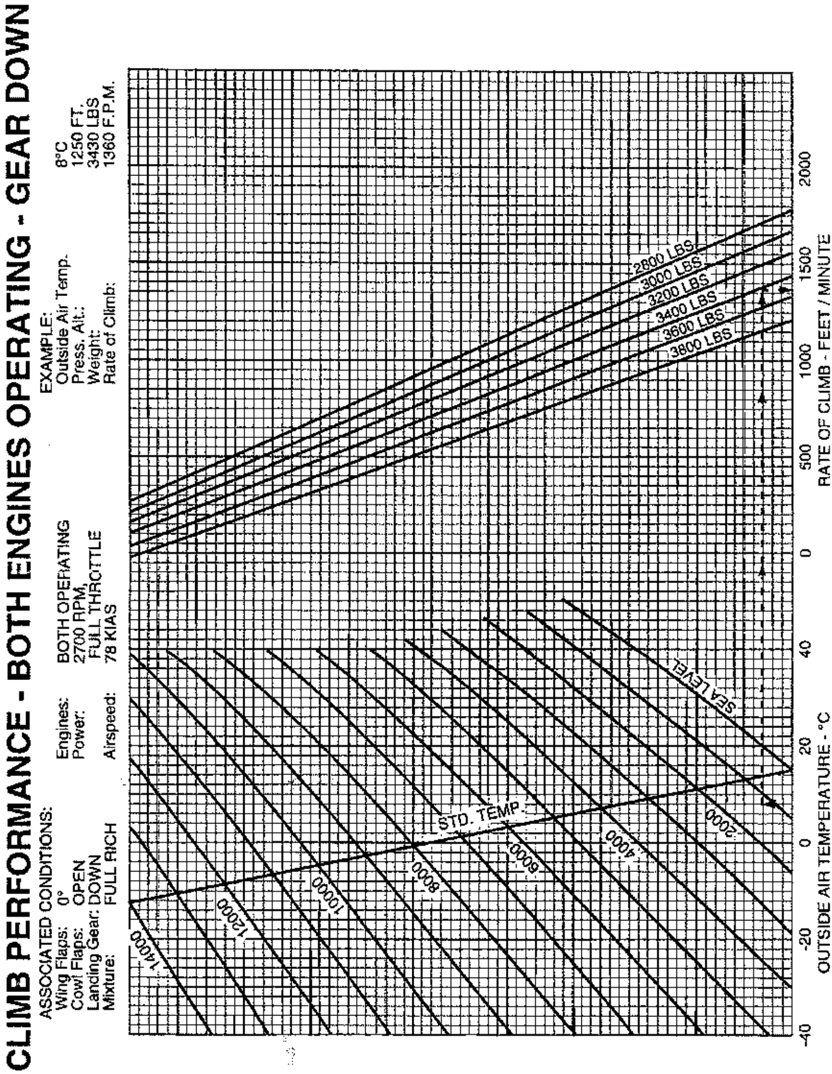

Climb Performance - Both Engines Operating - Gear Down
Figure 5-17

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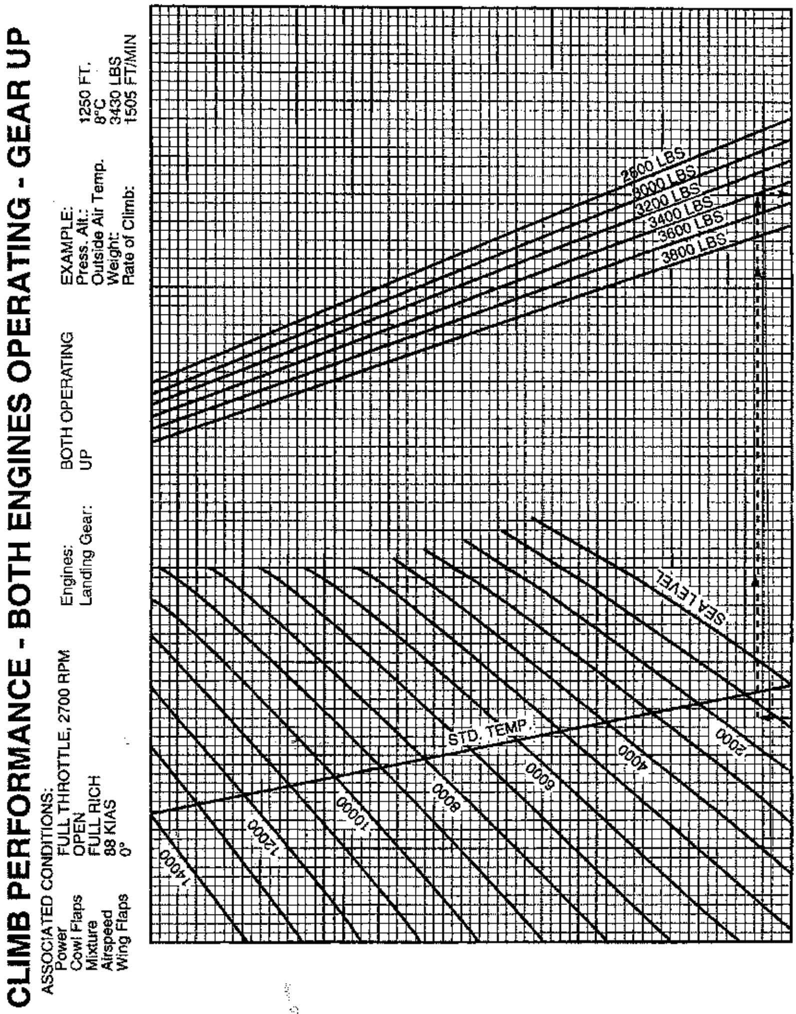
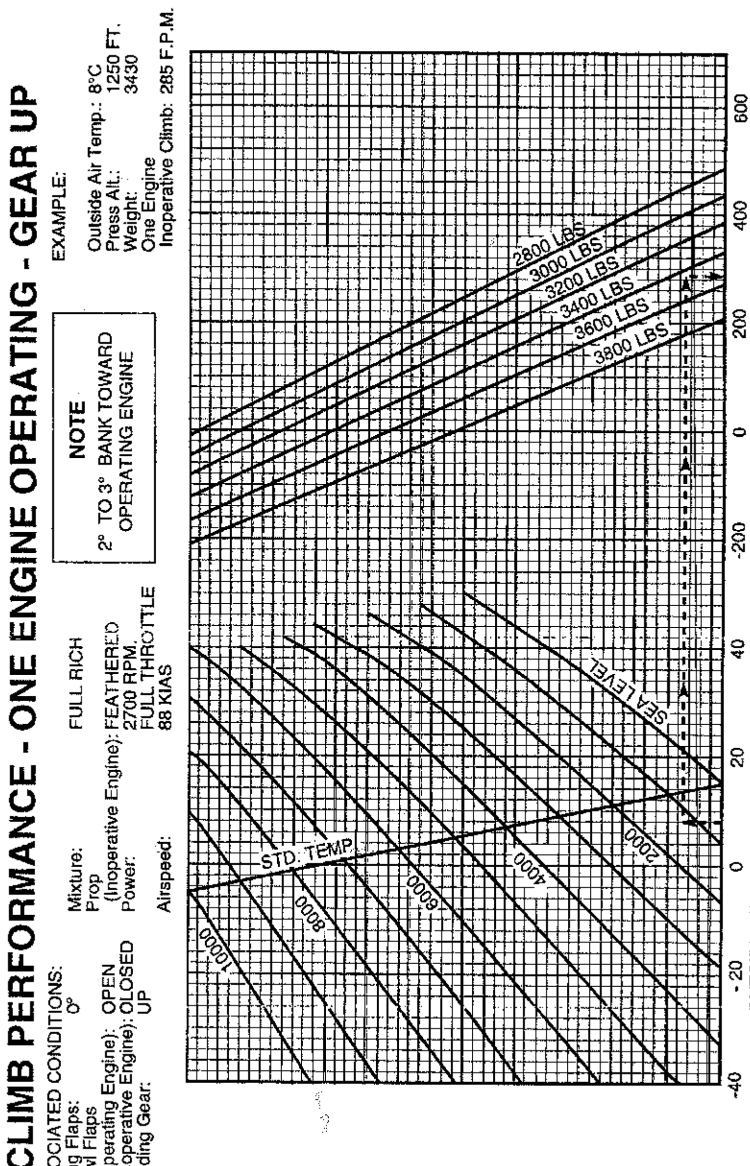
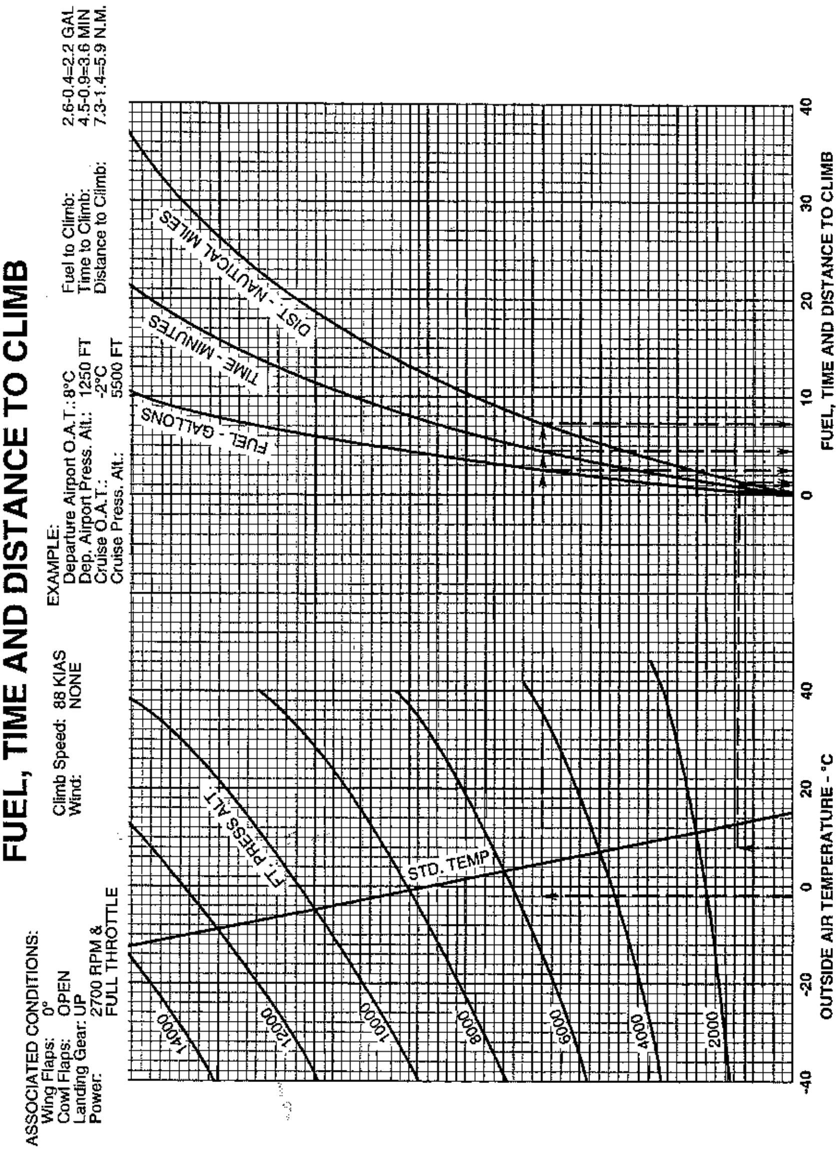


Climb Performance - Both Engines Operating - Gear Up
Figure 5-19



Climb Performance - One Engine Operating - Gear Up
Figure 5-21



Fuel, Time And Distance To Climb
Figure 5-23

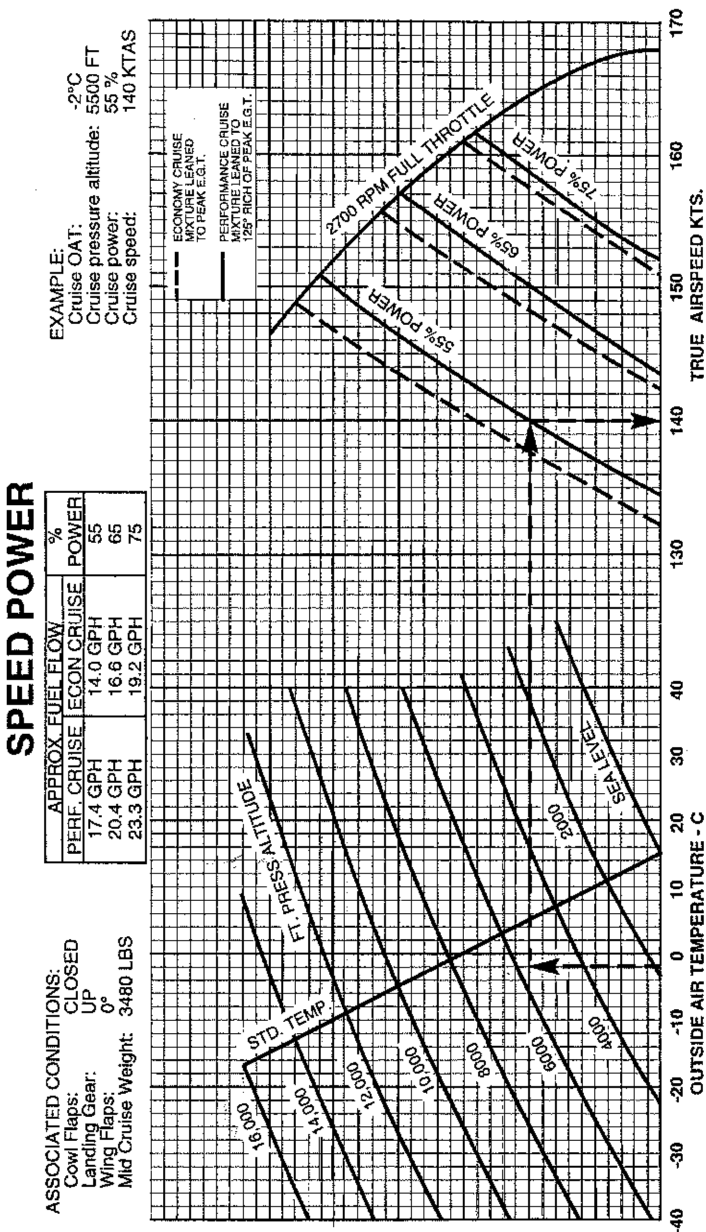
FUEL AND POWER SETTING TABLE

Press. Alt. Feet	Std. Alt. Temp. °C	99 BHP– 55% Rated Power Approx. Fuel Flow 8.7 G.P.H.* RPM AND MAN. PRESS.				117 BHP– 65% Rated Power Approx. Fuel Flow 10.2 G.P.H.* RPM AND MAN. PRESS.				135 BHP– 75% Rated Power Approx. Fuel Flow 11.7 G.P.H.* RPM AND MAN. PRESS.				Press. Alt. Feet
		2100	2200	2300	2400	2100	2200	2300	2400	2200	2300	2400	2500	
SL	15	22.3	21.7	21.1	20.6	24.9	24.2	23.5	22.9	26.7	26.0	25.2	24.6	SL
1000	13	22.0	21.3	20.8	20.3	24.6	23.8	23.2	22.6	26.3	25.6	24.9	24.3	1000
2000	11	21.7	21.0	20.5	20.0	24.2	23.5	22.9	22.3	25.9	25.3	24.6	24.0	2000
3000	9	21.3	20.7	20.2	19.8	23.9	23.2	22.6	22.0	25.6	25.0	24.4	23.7	3000
4000	7	21.1	20.5	20.0	19.5	23.5	22.8	22.3	21.8	FT	24.7	24.1	23.5	4000
5000	5	20.8	20.2	19.7	19.2	23.2	22.5	22.0	21.5	—	FT	23.8	23.2	5000
6000	3	20.5	19.9	19.4	19.0	22.9	22.2	21.7	21.3	—	—	FT	22.9	6000
7000	1	20.2	19.7	19.2	18.7	FT	21.9	21.5	21.0	—	—	—	FT	7000
8000	-1	20.0	19.4	18.9	18.5	—	FT	21.2	20.8					8000
9000	-3	19.7	19.1	18.7	18.2	—	—	FT	20.6					9000
10,000	-5	19.5	18.9	18.4	18.0	—	—	—	FT					10,000
11,000	-7	19.2	18.7	18.2	17.8									11,000
12,000	-9	FT	18.4	18.0	17.6									12,000
13,000	-11	—	FT	FT	17.4									13,000
14,000	-13	—	—	—	FT									14,000

NOTE: To maintain constant power, add approximately 1% Manifold Pressure for each 8°C above standard. Subtract approximately 1% for each 8°C below standard.

*PERFORMANCE CRUISE POWER

Fuel & Power Setting Table
Figure 5-25



APPROX. FUEL FLOW		%
PERF. CRUISE	ECON CRUISE	POWER
17.4 GPH	14.0 GPH	55
20.4 GPH	16.6 GPH	65
23.3 GPH	19.2 GPH	75

Speed Power
Figure 5-27

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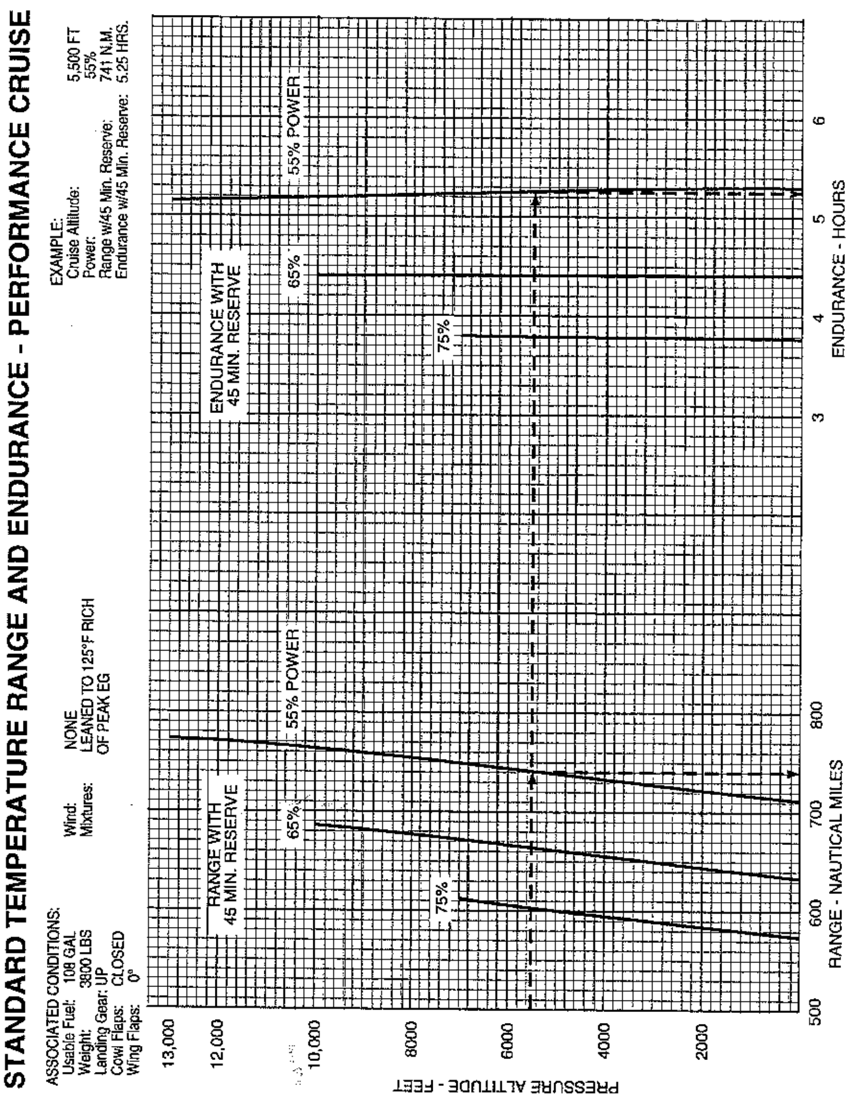
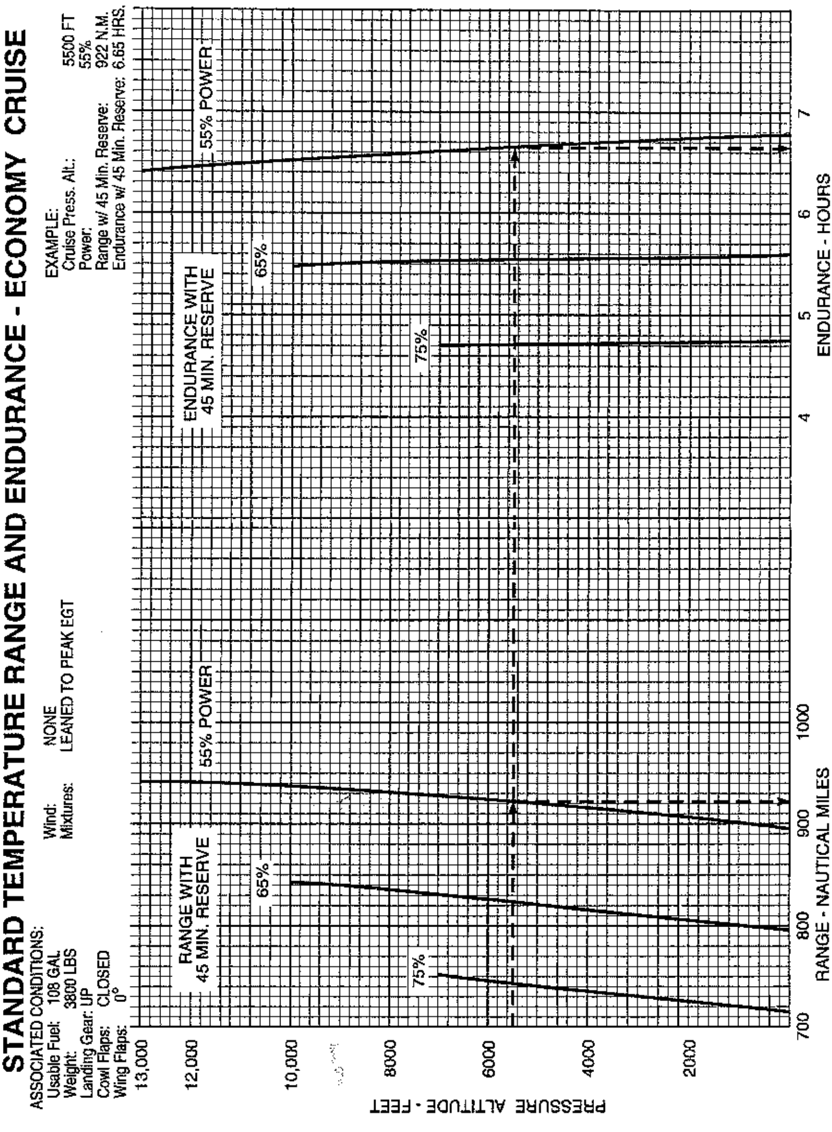
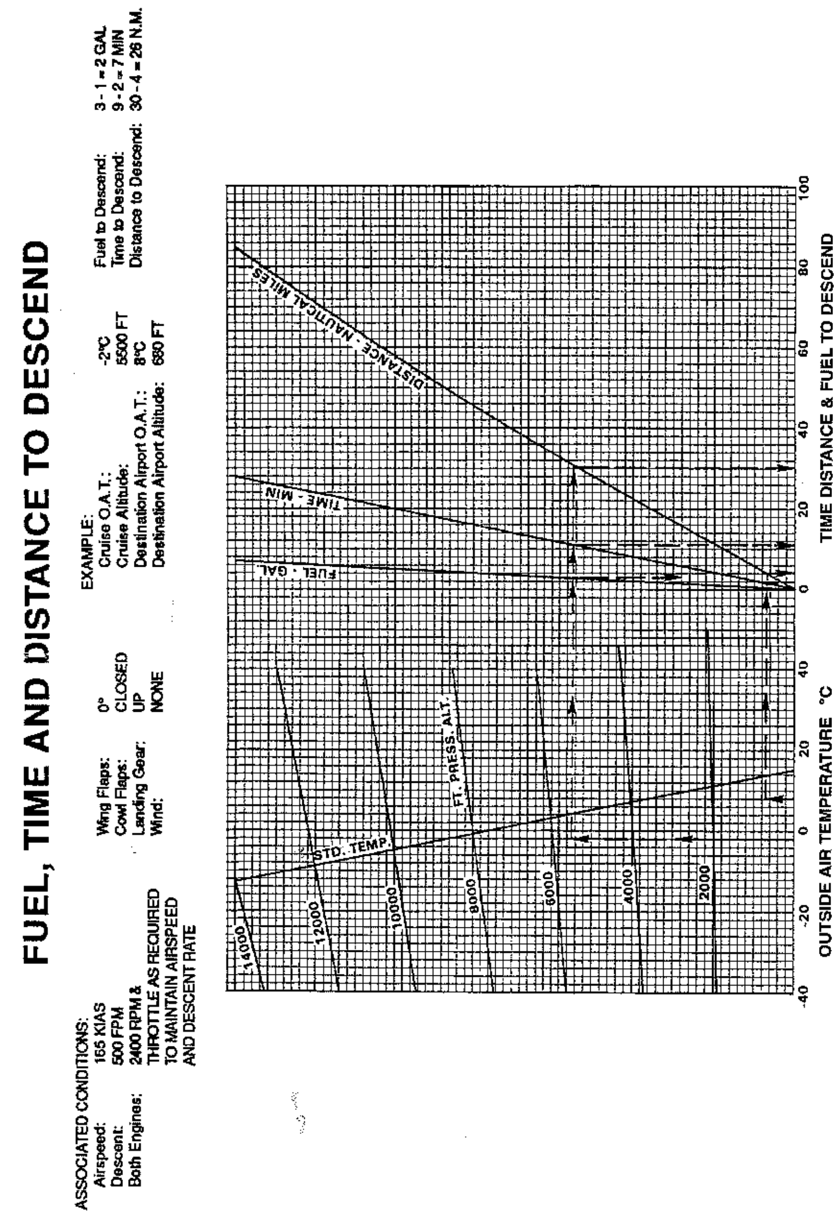


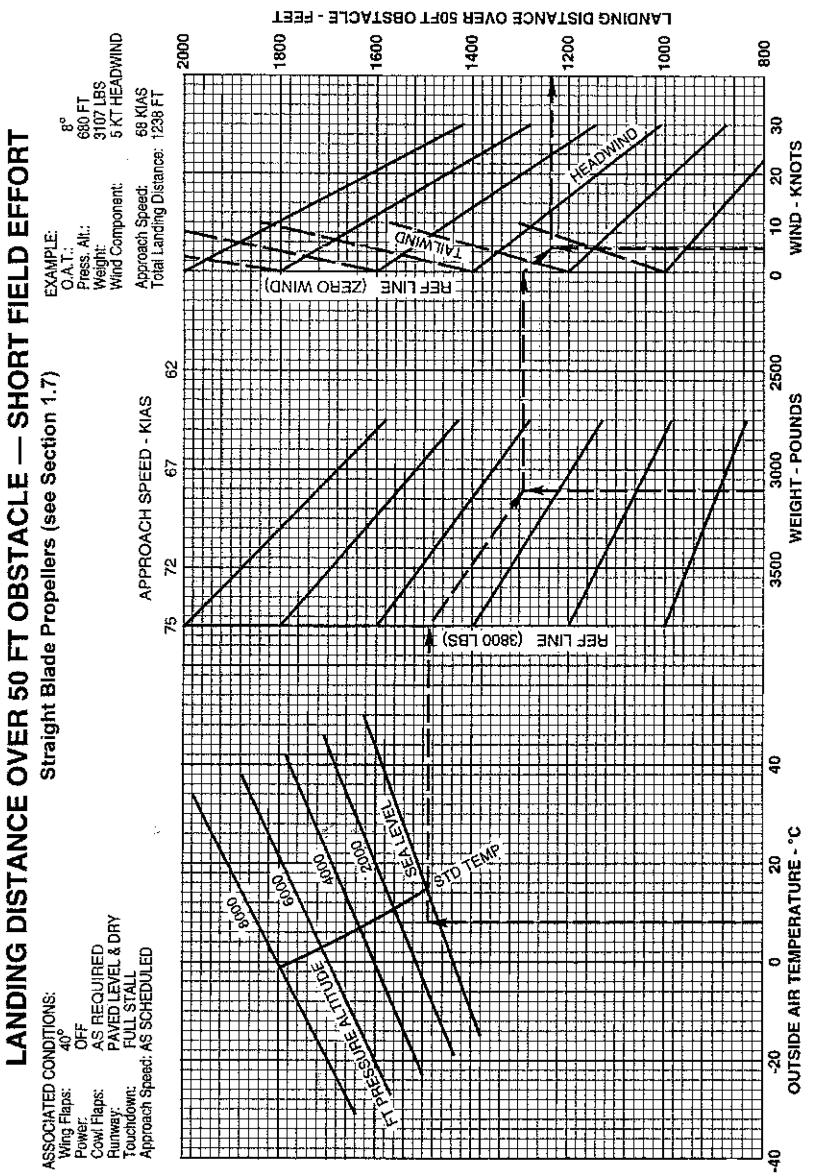
Standard Temperature Range And Endurance - Performance Cruise
Figure 5-29



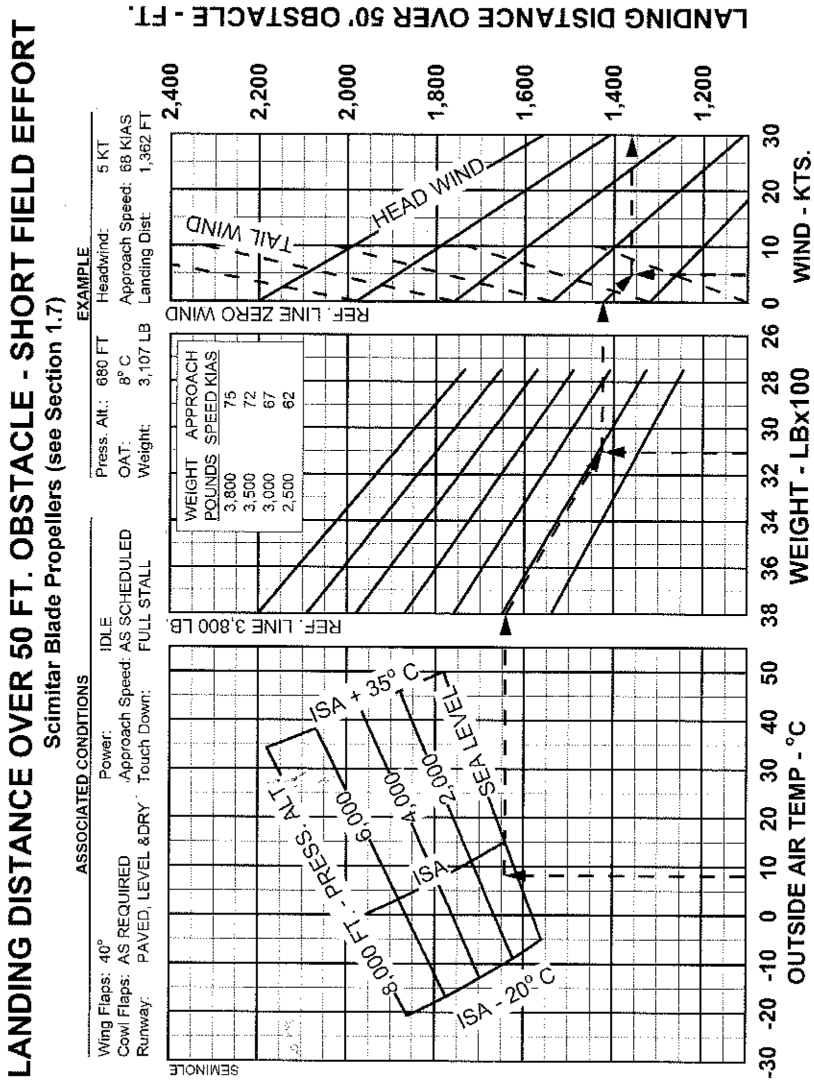
Standard Temperature Range And Endurance - Economy Cruise
Figure 5-31



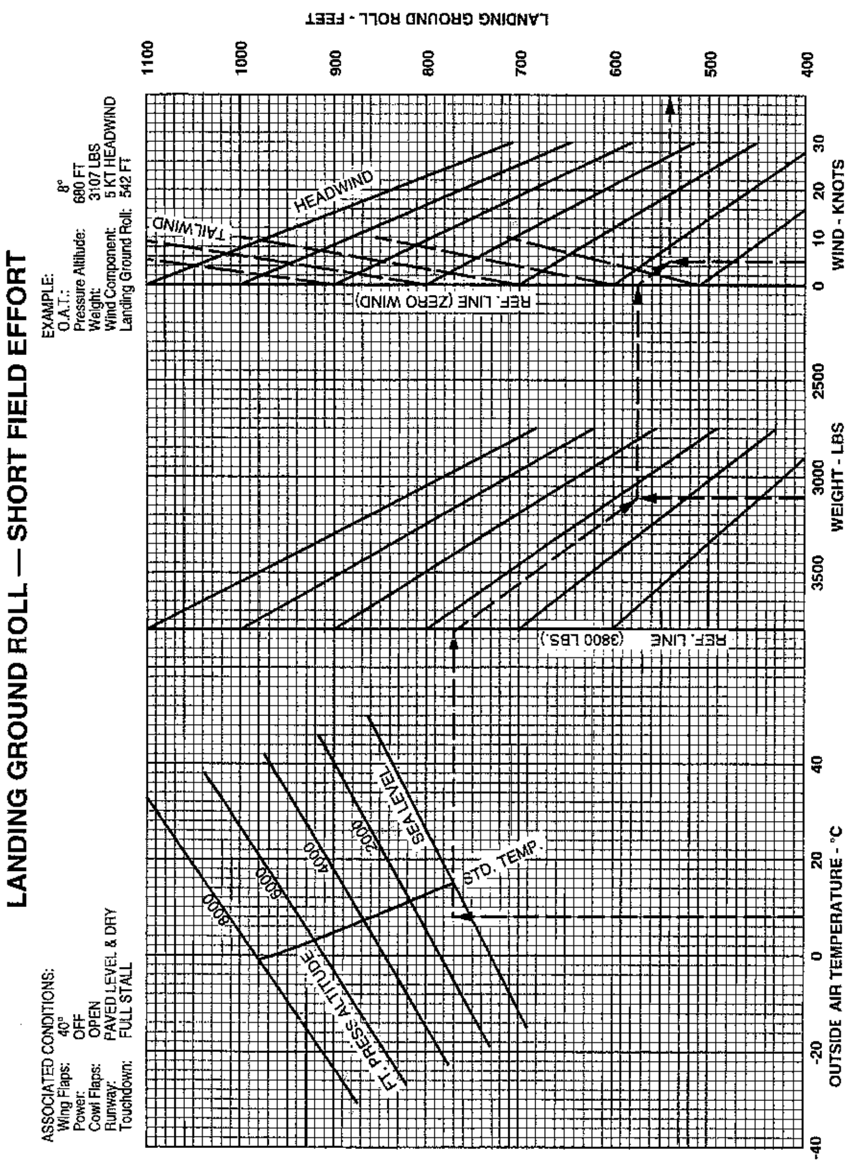
Fuel, Time And Distance To Descend
Figure 5-33



Landing Distance Over 50 Ft. Obstacle - Short Field Effort
Figure 5-35



Landing Distance Over 50 Ft. Obstacle - Short Field Effort
Figure 5-35a



Landing Ground Roll - Short Field Effort
Figure 5-37

TABLE OF CONTENTS

SECTION 6

WEIGHT AND BALANCE

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SECTION 6

WEIGHT AND BALANCE

6.1 GENERAL

In order to achieve the performance and flying characteristics which are designed into the airplane, it must be flown with the weight and center of gravity (C.G.) position within the approved operating range (envelope). Although the airplane offers flexibility of loading, it cannot be flown with the maximum number of adult passengers, full fuel tanks and maximum baggage. With the flexibility comes responsibility. The pilot must ensure that the airplane is loaded within the loading envelope before he makes a takeoff.

Misloading carries consequences for any aircraft. An overloaded airplane will not take off, climb or cruise as well as a properly loaded one. The heavier the airplane is loaded, the less climb performance it will have.

Center of gravity is a determining factor in flight characteristics. If the C.G. is too far forward in any airplane, it may be difficult to rotate for takeoff or landing. If the C.G. is too far aft, the airplane may rotate prematurely on takeoff or tend to pitch up during climb. Longitudinal stability will be reduced. This can lead to inadvertent stalls and even spins; and spin recovery becomes more difficult as the center of gravity moves aft of the approved limit.

A properly loaded airplane, however, will perform as intended. This airplane is designed to provide performance within the flight envelope. Before the airplane is delivered, it is weighed, and a basic empty weight and C.G. location is computed (basic empty weight consists of the standard empty weight of the airplane plus the optional equipment). Using the basic empty weight and C.G. location, the pilot can determine the weight and C.G. position for the loaded airplane by computing the total weight and moment and then determining whether they are within the approved envelope.

6.1 GENERAL (continued)

The basic empty weight and C.G. location are recorded in the Weight and Balance Data Form (Figure 6-5) and the Weight and Balance Record (Figure 6-7). The current values should always be used. Whenever new equipment is added or any modification work is done, the mechanic responsible for the work is required to compute a new basic empty weight and C.G. position and to write these in the Aircraft Log Book and the Weight and Balance Record. The owner should make sure that it is done.

A weight and balance calculation is necessary in determining how much fuel or baggage can be boarded so as to keep within allowable limits. Check calculations prior to adding fuel to ensure against overloading.

The following pages are forms used in weighing an airplane in production and in computing basic empty weight, C.G. position, and useful load. Note that the useful load includes usable fuel, baggage, cargo and passengers.

6.3 AIRPLANE WEIGHING PROCEDURE

Piper provides basic empty weight and center of gravity location for each airplane, when initial airworthiness is issued.

This data is provided on a **Weight and Balance Data Form (Figure 6-5) in Section 6 of the POH.**

The removal or addition of equipment or airplane modifications can affect the basic empty weight and center of gravity. The following is a weighing procedure to determine this basic empty weight and center of gravity location:

(a) Preparation

(1) Be certain that all items checked in the airplane equipment list are installed in the proper location in the airplane.
(2) Remove excessive dirt, grease, moisture, and foreign items such as rags and tools, from the airplane before weighing.
(3) Defuel airplane. Then open all fuel drains until all remaining fuel is drained. Operate each engine until all undrainable fuel is used and engine stops. Then add the unusable fuel (2.0 gallons total. 1.0 gallon each wing).