### NOTICE

AT THE TIME OF ISSUANCE, THIS INFORMATION MANUAL WAS AN EXACT DUPLICATE OF THE OFFICIAL PILOT'S OPERATING HANDBOOK AND FAA APPROVED AIRPLANE FLIGHT MANUAL AND IS TO BE USED FOR GENERAL PURPOSES ONLY.

NOT BE KEPT CURRENT AND. THEREFORE. CANNOT **USED** BF AS OFFICIAL THE PII OT'S SUBSTITUTE FOR OPERATING HANDBOOK AND FAA APPROVED MANUAL **INTENDED** AIRPI ANF FLIGHT OPERATION OF THE AIRPLANE.

THE PILOT'S OPERATING HANDBOOK MUST BE CARRIED IN THE AIRPLANE AND AVAILABLE TO THE PILOT AT ALL TIMES.

Cessna Aircraft Company Original Issue - 8 July 1998 Revision 5 - 19 July 2004

Revision 5 U.S. i

∎ ii

#### **PERFORMANCE - SPECIFICATIONS**

*SPEED:  Maximum at Sea Level
CRUISE: Recommended lean mixture with fuel allowance for engine start, taxi, takeoff, climb and 45 minutes reserve.  75% Power at 8500 Feet
Range at 10,000 Feet, 45% Power Range - 638 NM 53 Gallons Usable Fuel
RATE-OF-CLIMB AT SEA LEVEL
SERVICE CEILING
TAKEOFF PERFORMANCE: Ground Roll
LANDING PERFORMANCE:  Ground Roll
STALL SPEED: Flaps Up, Power Off
MAXIMUM WEIGHT:       2558 POUNDS         Ramp
STANDARD EMPTY WEIGHT1663 POUNDS
MAXIMUM USEFUL LOAD895 POUNDS
BAGGAGE ALLOWANCE
(Continued Next Page)

U.S. Revision 5

#### PERFORMANCE - SPECIFICATIONS (Continued)

WING LOADING: Lbs/Sq. Ft
POWER LOADING: Lbs/HP14.2
FUEL CAPACITY 56 GALLONS
OIL CAPACITY 8 QUARTS
ENGINE: Textron LycomingIO-360-L2A 180 BHP at 2700 RPM
PROPELLER: Fixed Pitch, Diameter

#### NOTE

\*Speed performance is shown for an airplane equipped with speed fairings which increase the speeds by approximately 2 knots. There is a corresponding difference in range, while all other performance figures are unchanged when speed fairings are installed.

The above performance figures are based on airplane weights at 2550 pounds, standard atmospheric conditions, level, hard-surfaced dry runways and no wind. They are calculated values derived from flight tests conducted by Cessna Aircraft Company under carefully documented conditions and will vary with individual airplanes and numerous factors affecting flight performance.

Revision 5 U.S. iii/iv



# Information Manual SKYHAVVK SP



#### Cessna Aircraft Company

#### Model 172S

THIS MANUAL INCORPORATES INFORMATION ISSUED IN THE PILOT'S OPERATING HANDBOOK AND FAA APPROVED AIRPLANE FLIGHT MANUAL AT REVISION 5 DATED 19 JULY 2004 (PART NUMBER 172SPHUS05).

COPYRIGHT © 1998 CESSNA AIRCRAFT COMPANY WICHITA, KANSAS USA

172SIM

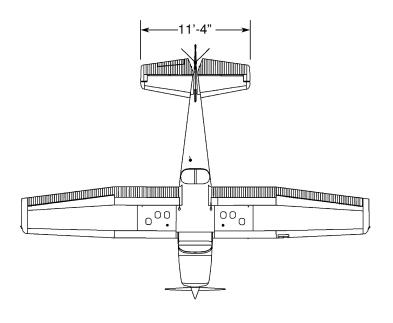
Revision 5 U.S. v/vi

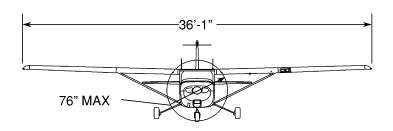
# **TABLE OF CONTENTS**

	S	Ε	C	TI	OI	Ν
GENERAL						1
LIMITATIONS						2
EMERGENCY PROCEDURES						3
NORMAL PROCEDURES						4
PERFORMANCE						5
WEIGHT AND BALANCE/EQUIPMENT LIST						6
AIRPLANE AND SYSTEMS DESCRIPTION						7
HANDLING, SERVICE AND MAINTENANCE						8
SUPPLEMENTS						9

# SECTION 1 GENERAL

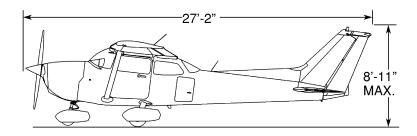
TABLE OF CONTENTS	Page
Three View - Normal Ground Attitude	1-2
Introduction	1-4
Descriptive Data	1-4
Engine	1-4
Propeller	1-4
Fuel	1-4
Oil	1-5
Maximum Certificated Weights	1-6
Standard Airplane Weights	1-7
Cabin And Entry Dimensions	1-7
Baggage Space And Entry Dimensions	1-7
Specific Loadings	1-7
Symbols, Abbreviations and Terminology	1-8
General Airspeed Terminology And Symbols	1-8
Meteorological Terminology	1-9
Engine Power Terminology	1-9
Airplane Performance And Flight Planning Terminology	1-10
Weight And Balance Terminology	1-11
Metric / Imperial / U.S. Conversion Charts	1-13
Weight Conversions	1-14
Length Conversions	1-16
Distance Conversions	1-20
Volume Conversions	1-21
Temperature Conversions	1-24
Hectopascals to Inches Mercury	1-25
Volume to Weight Conversions	1-26
Quick Conversions 1-2	7/1-28





0510T1005 0510T1005

Figure 1-1. Three View - Normal Ground Attitude (Sheet 1 of 2)



**NOTE 1:** WING SPAN SHOWN WITH STROBE LIGHTS INSTALLED.

NOTE 2: WHEEL BASE LENGTH IS 65".

NOTE 3: PROPELLER GROUND CLEARANCE IS 11 1/4".

**NOTE 4:** WING AREA IS 174 SQUARE FEET.

NOTE 5: MINIMUM TURNING RADIUS (\* PIVOT POINT TO OUTBOARD WING TIP) IS 27'-5 1/2".

NOTE 6: NORMAL GROUND ATTITUDE IS SHOWN WITH NOSE STRUT SHOWING APPROXIMATELY 2" OF STRUT, AND WINGS LEVEL.

0510T1005

Figure 1-1. Three View - Normal Ground Attitude (Sheet 2)

#### INTRODUCTION

This handbook contains 9 sections, and includes the material required to be furnished to the pilot by FAR Part 23. It also contains supplemental data supplied by Cessna Aircraft Company.

Section 1 provides basic data and information of general interest. It also contains definitions or explanations of symbols, abbreviations, and terminology commonly used.

#### **DESCRIPTIVE DATA**

#### **ENGINE**

Number of Engines: 1.

Engine Manufacturer: Textron Lycoming. Engine Model Number: IO-360-L2A.

Engine Type: Normally aspirated, direct drive, air-cooled,

horizontally opposed, fuel injected, four cylinder

engine with 360 cu. in. displacement. Horsepower Rating and Engine Speed: 180 rated BHP

at 2700 RPM.

#### **PROPELLER**

Propeller Manufacturer: McCauley Propeller Systems.

Propeller Model Number: 1A170E/JHA7660.

Number of Blades: 2.

Propeller Diameter: 76 inches. Propeller Type: Fixed pitch.

#### **FUEL**

#### **WARNING**

USE OF UNAPPROVED FUELS MAY RESULT IN DAMAGE TO THE ENGINE AND FUEL SYSTEM COMPONENTS, RESULTING IN POSSIBLE ENGINE FAILURE.

Approved Fuel Grades (and Colors): 100LL Grade Aviation Fuel (Blue). 100 Grade Aviation Fuel (Green).

1-4 Revision 4

#### NOTE

Isopropyl alcohol or diethylene glycol monomethyl ether (DiEGME) may be added to the fuel supply. Additive concentrations shall not exceed 1% for isopropyl alcohol or 0.10% to 0.15% for DiEGME. Refer to Section 8 for additional information.

#### Fuel Capacity:

Total Capacity: 56.0 U.S. gallons. Total Usable: 53.0 U.S. gallons.

Total Capacity Each Tank: 28.0 U.S. gallons. Total Usable Each Tank: 26.5 U.S. gallons.

#### NOTE

To ensure maximum fuel capacity and minimize cross-feeding when refueling, always park the airplane in a wings-level, normal ground attitude and place the fuel selector in the Left or Right position. Refer to Figure 1-1 for normal ground attitude dimensions.

#### OIL

#### Oil Specification:

MIL-L-6082 or SAE J1966 Aviation Grade Straight Mineral Oil: Used when the airplane was delivered from the factory and should be used to replenish the supply during the first 25 hours. This oil should be drained and the filter changed after the first 25 hours of operation. Refill the engine with MIL-L-6082 or SAE J1966 Aviation Grade Straight Mineral Oil and continue to use until a total of 50 hours has accumulated or oil consumption has stabilized.

MIL-L-22851 or SAE J1899 Aviation Grade Ashless Dispersant Oil: Oil conforming to the latest revision and/or supplements to Textron Lycoming Service Instruction No. 1014, **must be used** after first 50 hours or once oil consumption has stabilized.

#### Recommended Viscosity for Temperature Range:

Temperature	MIL-L-6082 or SAE J1966 Straight Mineral Oil SAE Grade	MIL-L-22851 or SAE J1899 Ashless Dispersant SAE Grade
Above 27°C (80°F)	60	15W-50, 20W-50 or 60
Above 16°C (60°F)	50	40 or 50
-1°C (30°F) to 32°C (90°F)	40	40
-18°C (0°F) to 21°C (70°F)	30	30, 40 or 20W-40
Below -12°C (10°F)	20	30 or 20W-30
-18°C (0°F) to 32°C (90°F)	20W-50	20W-50 or 15W-50
All Temperatures		15W-50 or 20W-50

#### NOTE

When operating temperatures overlap, use the lighter grade of oil.

Oil Capacity: Sump: 8 U.S. Quarts Total: 9 U.S. Quarts

#### **MAXIMUM CERTIFICATED WEIGHTS**

Ramp Weight	Normal Category: Utility Category:	2558 lbs. 2208 lbs.
Takeoff Weight	Normal Category: Utility Category:	2550 lbs. 2200 lbs.
Landing Weight	Normal Category: Utility Category:	2550 lbs. 2200 lbs.

1-6 Revision 4 Weight in Baggage Compartment, Normal Category:

Baggage Area 1 (Station 82 to 108): 120 lbs. See note below. Baggage Area 2 (Station 108 to 142): 50 lbs. See note below.

#### NOTE

The maximum combined weight capacity for Baggage Area 1 and Baggage Area 2 is 120 lbs.

Weight in Baggage Compartment, Utility Category:

In this category, the rear seat must not be occupied and the baggage compartment must be empty.

#### STANDARD AIRPLANE WEIGHTS

Standard Empty Weight: 1663 lbs.

Maximum Useful Load, Normal Category 895 lbs.

Maximum Useful Load, Utility Category: 545 lbs.

#### CABIN AND ENTRY DIMENSIONS

Detailed dimensions of the cabin interior and entry door openings are illustrated in Section 6.

#### BAGGAGE SPACE AND ENTRY DIMENSIONS

Dimensions of the baggage area and baggage door opening are illustrated in detail in Section 6.

#### SPECIFIC LOADINGS

Wing Loading: 14.7 lbs./sq. ft. Power Loading: 14.2 lbs./hp.

# SYMBOLS, ABBREVIATIONS AND TERMINOLOGY GENERAL AIRSPEED TERMINOLOGY AND SYMBOLS

KCAS Knots Calibrated Airspeed is indicated airspeed corrected for position and instrument error and expressed in knots. Knots calibrated airspeed is equal to KTAS in standard atmosphere at sea level.

KIAS Knots Indicated Airspeed is the speed shown on the airspeed indicator and expressed in knots.

KTAS Knots True Airspeed is the airspeed expressed in knots relative to undisturbed air which is KCAS corrected for altitude and temperature.

V<sub>A</sub> **Maneuvering Speed** is the maximum speed at which full or abrupt control movements may be used without overstressing the airframe.

V<sub>FE</sub> **Maximum Flap Extended Speed** is the highest speed permissible with wing flaps in a prescribed extended position.

V<sub>NO</sub> **Maximum Structural Cruising Speed** is the speed that should not be exceeded except in smooth air, then only with caution.

V<sub>NE</sub> Never Exceed Speed is the speed limit that may not be exceeded at any time.

V<sub>S</sub> Stalling Speed or the minimum steady flight speed is the minimum speed at which the airplane is controllable.

V<sub>SO</sub>

Stalling Speed or the minimum steady flight speed is the minimum speed at which the airplane is controllable in the landing configuration at the most forward center of gravity.

V<sub>X</sub>

Best Angle-of-Climb Speed is the speed which results in the greatest gain of altitude in a given horizontal distance.

Vy **Best Rate-of-Climb Speed** is the speed which results in the greatest gain in altitude in a given time.

1-8 Revision 4

#### METEOROLOGICAL TERMINOLOGY

OAT Outside Air Temperature is the free air static

temperature. It may be expressed in either degrees

Celsius or degrees Fahrenheit.

Standard **Standard Temperature** is 15°C at sea level

Temperature pressure altitude and decreases by 2°C for each

1000 feet of altitude.

Pressure **Pressure Altitude** is the altitude read from an

Altitude altimeter when the altimeter's barometric scale has

been set to 29.92 inches of mercury (1013 mb).

**ENGINE POWER TERMINOLOGY** 

BHP Brake Horsepower is the power developed by the

engine.

RPM **Revolutions Per Minute** is engine speed.

Static Static RPM is engine speed attained during a full

RPM throttle engine runup when the airplane is on the

ground and stationary.

MAP **Manifold Absolute Pressure** is the absolute

pressure measured in the engine induction system. MAP is measured in units of inches of mercury

(inHG).

Lean Decreased proportion of fuel in the fuel-air mixture

Mixture supplied to the engine. As air density decreases,

the amount of fuel required by the engine decreases for a given throttle setting. Adjusting the fuel-air mixture to provide a smaller portion of fuel is known

as "leaning" the mixture.

Rich Increased proportion of fuel in the fuel-air mixture

Mixture Supplied to the engine. As air density increases, t

supplied to the engine. As air density increases, the amount of fuel required by the engine increases for a given throttle setting. Adjusting the fuel-air mixture to provide a greater portion of fuel is known as

"richening" the mixture.

Full Rich Mixture control full forward (pushed in, full control

travel, toward the panel).

Idle Cutoff Mixture control full aft (pulled out, full control travel,

away from the panel).

#### **ENGINE POWER TERMINOLOGY** (Continued)

Full Throttle full forward (pushed in, full control travel, toward the panel) Also known as "full open" throttle.

Closed Throttle full aft (pulled out, full control travel, away from the panel). Also known as the throttle "idle" position.

# AIRPLANE PERFORMANCE AND FLIGHT PLANNING TERMINOLOGY

Demonstrated Crosswind Velocity is the velocity of the crosswind component for which adequate control of the airplane during takeoff and landing was actually demonstrated during certification tests. The value shown is not considered to be limiting.

Unusable **Unusable Fuel** is the quantity of fuel that can not be safely used in flight.

GPH Gallons Per Hour is the amount of fuel consumed per hour.

NMPG Nautical Miles Per Gallon is the distance which can be expected per gallon of fuel consumed at a

specific engine power setting and/or flight configuration.

configuration.

g **g** is acceleration due to gravity.

Course Datum is the compass reference used by the autopilot, along with course deviation, to provide letteral control when tracking a povingation signal.

lateral control when tracking a navigation signal.

1-10 Revision 4

#### **WEIGHT AND BALANCE TERMINOLOGY**

Reference Datum	<b>Reference Datum</b> is an imaginary vertical plane from which all horizontal distances are measured for balance purposes.
Station	<b>Station</b> is a location along the airplane fuselage given in terms of the distance from the reference datum.
Arm	<b>Arm</b> is the horizontal distance from the reference datum to the center of gravity (C.G.) of an item.
Moment	<b>Moment</b> is the product of the weight of an item multiplied by its arm. (Moment divided by the constant 1000 is used in this handbook to simplify balance calculations by reducing the number of digits.)
Center of Gravity (C.G.)	<b>Center of Gravity</b> is the point at which an airplane, or equipment, would balance if suspended. Its distance from the reference datum is found by dividing the total moment by the total weight of the airplane.
C.G. Arm	<b>Center of Gravity Arm</b> is the arm obtained by adding the airplane's individual moments and dividing the sum by the total weight.
C.G. Limits	<b>Center of Gravity Limits</b> are the extreme center of gravity locations within which the airplane must be operated at a given weight.
Standard Empty Weight	Standard Empty Weight is the weight of a standard airplane, including unusable fuel, full operating fluids and full engine oil.
Basic Empty Weight	Basic Empty Weight is the standard empty weight plus the weight of optional equipment.
Useful Load	<b>Useful Load</b> is the difference between ramp weight and the basic empty weight.
MAC	MAC (Mean Aerodynamic Chord) is the chord of an imaginary rectangular airfoil having the same pitching

July 8/98 1-11

actual wing.

moments throughout the flight range as that of the

#### WEIGHT AND BALANCE TERMINOLOGY (Continued)

Maximum Ramp Weight	<b>Maximum Ramp Weight</b> is the maximum weight approved for ground maneuver, and includes the weight of fuel used for start, taxi and runup.
Maximum Takeoff Weight	<b>Maximum Takeoff Weight</b> is the maximum weight approved for the start of the takeoff roll.
Maximum Landing Weight	<b>Maximum Landing Weight</b> is the maximum weight approved for the landing touchdown.
Tare	<b>Tare</b> is the weight of chocks, blocks, stands, etc. used when weighing an airplane, and is included in the scale readings. Tare is deducted from the scale reading to obtain the actual (net) airplane weight.

1-12 July 8/98

#### METRIC / IMPERIAL / U.S. CONVERSION CHARTS

The following charts have been provided to help international operators convert U.S. measurement supplied with the Pilot's Operating Handbook into metric and imperial measurements.

The standard followed for measurement units shown, is the National Institute of Standards Technology (NIST), Publication 811, "Guide for the Use of the International System of Units (SI)."

Please refer to the following pages for these charts.

May 30/00 1-13

(Kilograms  $\times$  2.205 = Pounds) (Pounds  $\times$  .454 = Kilograms)

#### KILOGRAMS INTO POUNDS KILOGRAMMES EN LIVRES

kg	0	1	2	3	4	5	6	7	8	9
	lb.									
0		2.205	4.409	6.614	8.819	11.023	13.228	15.432	17.637	19.842
10	22.046	24.251	26.456	28.660	30.865	33.069	35.274	37.479	39.683	41.888
20	44.093	46.297	48.502	50.706	52.911	55.116	57.320	59.525	61.729	63.934
30	66.139	68.343	70.548	72.753	74.957	77.162	79.366	81.571	83.776	85.980
40	88.185	90.390	92.594	94.799	97.003	99.208	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26
100	220.46	222.67	224.87	227.08	229.28	231.49	233.69	235.90	238.10	240.30

#### POUNDS INTO KILOGRAMS LIVRES EN KILOGRAMMES

lb.	0	1	2	3	4	5	6	7	8	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	26.303	26.762
60	27.216	27.669	28.123	28.576	29.030	29.484	29.937	30.391	30.844	31.298
70	31.752	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	41.731	42.184	42.638	43.091	43.545	43.999	44.452	44.906
100	45.359	45.813	46.266	46.720	47.174	47.627	48.081	48.534	48.988	49.442

Figure 1-2. Weight Conversions (Sheet 1 of 2)

1-14 July 8/98

(Kilograms  $\times$  2.205 = Pounds) (Pounds  $\times$  .454 = Kilograms)

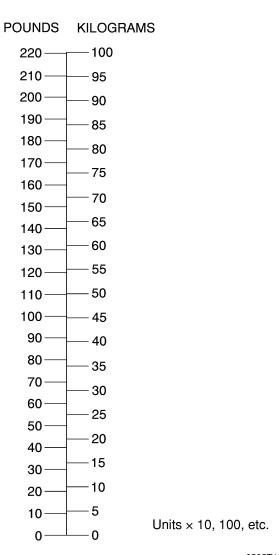


Figure 1-2. Weight Conversions (Sheet 2)

0585T1027

 $(Meters \times 3.281 = Feet)$   $(Feet \times .305 = Meters)$ 

# METERS INTO FEET METRES EN PIEDS

m	0	1	2	3	4	5	6	7	8	9
	feet									
0		3.281	6.562	9.842	13.123	16.404	19.685	22.956	26.247	29.528
10	32.808	36.089	39.370	42.651	45.932	49.212	52.493	55.774	59.055	62.336
20	65.617	68.897	72.178	75.459	78.740	82.021	85.302	88.582	91.863	95.144
30	98.425	101.71	104.99	108.27	111.55	114.83	118.11	121.39	124.67	127.95
40	131.23	134.51	137.79	141.08	144.36	147.64	150.92	154.20	157.48	160.76
50	164.04	167.32	170.60	173.86	177.16	180.45	183.73	187.01	190.29	193.57
60	195.85	200.13	203.41	206.69	209.97	213.25	216.53	219.82	223.10	226.38
70	229.66	232.94	236.22	239.50	242.78	246.06	249.34	252.62	255.90	259.19
80	262.47	265.75	269.03	272.31	275.59	278.87	282.15	285.43	288.71	291.58
90	295.27	298.56	301.84	305.12	308.40	311.68	314.96	318.24	321.52	324.80
100	328.08	331.36	334.64	337.93	341.21	344.49	347.77	351.05	354.33	357.61

# FEET INTO METERS PIEDS EN METRES

ft	0	1	2	3	4	5	6	7	8	9
	m	m	m	m	m	m	m	m	m	m
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	5.486	5.791
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50	15.240	15.545	15.850	16.154	16.459	16.754	17.069	17.374	17.678	17.983
60	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100	30.480	30.785	31.090	31.394	31.699	32.004	32.309	32.614	32.918	33.223

Figure 1-3. Length Conversions (Sheet 1 of 2)

1-16 May 30/00

 $(Meters \times 3.281 = Feet)$   $(Feet \times .305 = Meters)$ 

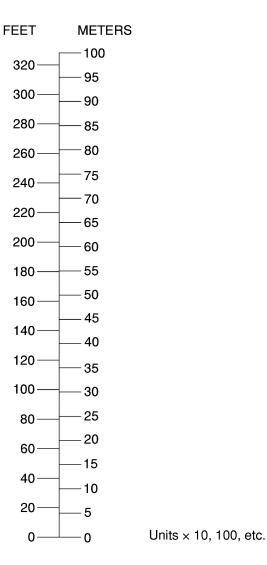


Figure 1-3. Length Conversions (Sheet 2)

(Centimeters  $\times$  .394 = Inches) (Inches  $\times$  2.54 = Centimeters)

## CENTIMETERS INTO INCHES CENTIMETRES EN POUCES

cm	0	1	2	3	4	5	6	7	8	9
	in.									
0		0.394	0.787	1.181	1.575	1.969	2.362	2.756	3.150	3.543
10	3.937	4.331	4.724	5.118	5.512	5.906	6.299	6.693	7.087	7.480
20	7.874	8.268	8.661	9.055	9.449	9.843	10.236	10.630	11.024	11.417
30	11.811	12.205	12.598	12.992	13.386	13.780	14.173	14.567	14.961	15.354
40	15.748	16.142	16.535	16.929	17.323	17.717	18.110	18.504	18.898	19.291
50	19.685	20.079	20.472	20.866	21.260	21.654	22.047	22.441	22.835	23.228
60	23.622	24.016	24.409	24.803	25.197	25.591	25.984	26.378	26.772	27.164
70	27.559	27.953	28.346	28.740	29.134	29.528	29.921	30.315	30.709	31.102
80	31.496	31.890	32.283	32.677	33.071	33.465	33.858	34.252	34.646	35.039
90	35.433	35.827	36.220	36.614	37.008	37.402	37.795	38.189	38.583	38.976
100	39.370	39.764	40.157	40.551	40.945	41.339	41.732	42.126	42.520	42.913

# INCHES INTO CENTIMETERS POUCES EN CENTIMETRES

in.	0	1	2	3	4	5	6	7	8	9
	cm									
0		2.54	5.08	7.62	10.16	12.70	15.24	17.78	20.32	22.96
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

Figure 1-4. Length Conversions (Sheet 1 of 2)

1-18 May 30/00

0585T1028

(Centimeters  $\times$  .394 = Inches) (Inches  $\times$  2.54 = Centimeters) INCHES **CENTIMETERS** 10-- 25 - 24 - 23 9-- 22 - 21 8-**– 20** - 19 - 18 7-- 17 - 16 6-- 15 - 14 - 13 5-- 12 - 11 - 10 - 9 - 8 3-- 7 - 6 2-- 5 4 Units × 10, 100, etc. - 3 1-- 2

Figure 1-4. Length Conversions (Sheet 2)

- 1

(Statute Miles ×1.609=Kilometers) (Kilometers ×.622=Statute Miles) (Statute Miles ×.869=Nautical Miles) (Nautical Miles ×1.15=Statute Miles) (Nautical Miles ×1.852=Kilometers) (Kilometers ×.54=Nautical Miles)

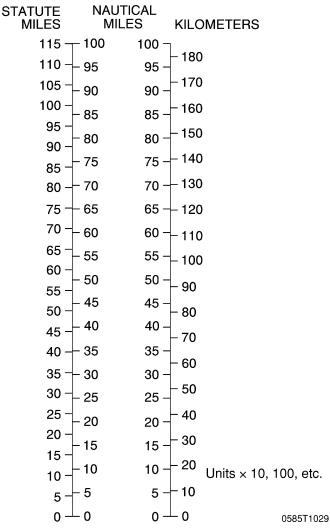


Figure 1-5. Distance Conversions

(Imperial Gallons  $\times$  4.546 = Liters) (Liters  $\times$  .22 = Imperial Gallons)

#### **LITERS INTO IMPERIAL GALLONS** LITRES EN GALLONS IMPERIAL

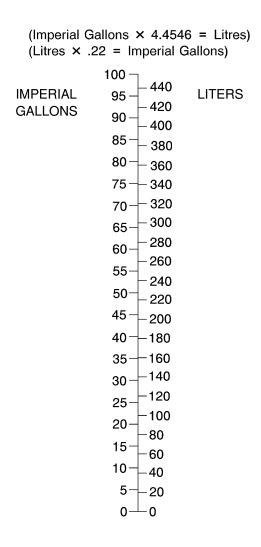
Lt	0	1	2	3	4	5	6	7	8	9
	G	G	G	G	G	IG	G	G	IG	IG
0		0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.960	4.180
20	4.400	4.620	4.840	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.699	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.779
50	10.999	11.219	11.439	11.659	11.879	12.099	12.319	12.539	12.759	12.979
60	13.199	13.419	13.639	13.859	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.038	18.258	18.478	18.698	18.918	19.138	19.358	19.578
90	19.798	20.018	20.238	20.458	20.678	20.898	21.118	21.338	21.558	21.778
100	21.998	22.218	22.438	22.658	22.878	23.098	23.318	23.537	23.757	23.977

#### **IMPERIAL GALLONS INTO LITERS GALLONS IMPERIAL EN LITRES**

IG	0	1	2	3	4	5	6	7	8	9
	Lt									
0		4.546	9.092	13.638	18.184	22.730	27.276	31.822	36.368	40.914
10	45.460	50.006	54.552	59.097	63.643	68.189	72.735	77.281	81.827	86.373
20	90.919	95.465	100.01	104.56	109.10	113.65	118.20	122.74	127.29	131.83
30	136.38	140.93	145.47	150.02	154.56	159.11	163.66	168.20	172.75	177.29
40	181.84	186.38	190.93	195.48	200.02	204.57	209.11	213.66	218.21	222.75
50	227.30	231.84	236.39	240.94	245.48	250.03	254.57	259.12	263.67	268.21
60	272.76	277.30	281.85	286.40	290.94	295.49	300.03	304.58	309.13	313.67
70	318.22	322.76	327.31	331.86	336.40	340.95	345.49	350.04	354.59	359.13
80	363.68	368.22	372.77	377.32	381.86	386.41	390.95	395.50	400.04	404.59
90	409.14	413.68	418.23	422.77	427.32	431.87	436.41	440.96	445.50	450.05
100	454.60	459.14	463.69	468.23	472.78	477.33	481.87	486.42	490.96	495.51

Figure 1-6. Volume Conversions (Sheet 1 of 3)

May 30/00 1-21



Units × 10, 100, etc. 0585T1032

Figure 1-6. Volume Conversions (Sheet 2 of 3)

(Imperial Gallons × 1.2 = U.S. Gallons) (U.S. Gallons × .833 = Imperial Gallons) (U.S. Gallons × 3.785 = Liters) (Liters × .264 = U.S. Gallons)

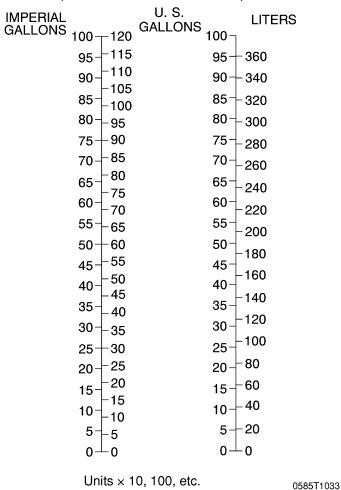
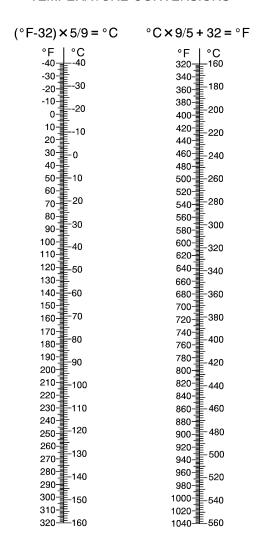


Figure 1-6. Volume Conversions (Sheet 3 of 3)

May 30/00 1-23

#### TEMPERATURE CONVERSIONS



0585T1034

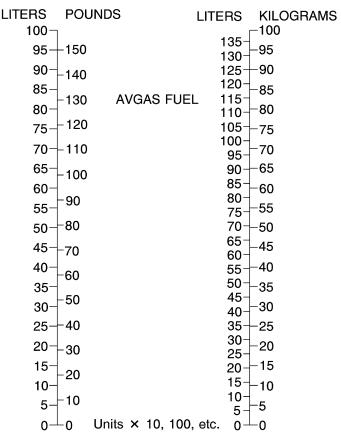
Figure 1-7. Temperature Conversions

# PRESSURE CONVERSION HECTOPASCALS (MILLIBARS) TO INCHES MERCURY (inHG)



Figure 1-8. Hectopascals to Inches Mercury

AVGAS Specific Gravity = .72
(Liters X .72 = Kilograms) - (Kilograms X 1.389 = Liters)
(Liters X 1.58 = Pounds) - (Pounds X .633 = Liters)



0585T1030

Figure 1-9. Volume to Weight Conversion

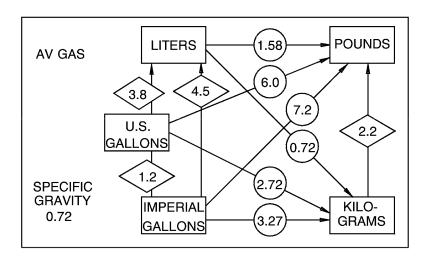


Figure 1-10. Quick Conversions

### SECTION 2 LIMITATIONS

TABLE OF CONTENTS	Page
Introduction	2-3
Airspeed Limitations	2-4
Airspeed Indicator Markings	2-5
Powerplant Limitations	2-5
Powerplant Instrument Markings	2-6
Weight Limits	2-7
Normal Category	2-7
Utility Category	2-7
Center Of Gravity Limits	2-7
Normal Category	2-7
Utility Category	2-8
Maneuver Limits	2-8
Normal Category	2-8
Utility Category	2-9
Flight Load Factor Limits	2-10
Normal Category	2-10
Utility Category	2-10
Kinds Of Operation Limits	2-10
Fuel Limitations	2-11
Additional Fuel Limitations	2-11
Other Limitations	2-11
Flap Limitations	2-11
Placarde	2-12

#### INTRODUCTION

Section 2 includes operating limitations, instrument markings, and basic placards necessary for the safe operation of the airplane, its engine, standard systems and standard equipment. The limitations included in this section and in Section 9 have been approved by the Federal Aviation Administration. Observance of these operating limitations is required by Federal Aviation Regulations.

#### NOTE

Refer to the Supplements, Section 9, of this Pilot's Operating Handbook for amended operating limitations, operating procedures, performance data and other necessary information for airplanes equipped with specific options.

#### NOTE

The airspeeds listed in the Airspeed Limitations chart (Figure 2-1) and the Airspeed Indicator Markings chart (Figure 2-2) are based on Airspeed Calibration data shown in Section 5 with the normal static source. If the alternate static source is being used, ample margins should be observed to allow for the airspeed calibration variations between the normal and alternate static sources as shown in Section 5.

The Cessna Model 172S is certificated under FAA Type Certificate No. 3A12.

May 30/00 2-3

#### **AIRSPEED LIMITATIONS**

Airspeed limitations and their operational significance are shown in Figure 2-1. Maneuvering speeds shown apply to normal category operations. The utility category maneuvering speed is 98 KIAS at 2200 pounds.

SYMBOL	SPEED	KCAS	KIAS	REMARKS
V <sub>NE</sub>	Never Exceed Speed	160	163	Do not exceed this speed in any operation.
V <sub>NO</sub>	Maximum Structural Cruising Speed	126	129	Do not exceed this speed except in smooth air, and then only with caution.
VA	Maneuvering Speed: 2550 Pounds 2200 Pounds 1900 Pounds	102 95 88	105 98 90	Do not make full or abrupt control movements above this speed.
V <sub>FE</sub>	Maximum Flap Extended Speed: 10° Flaps 10° to 30° Flaps	107 85	110 85	Do not exceed this speed with flaps down.
	Maximum Window Open Speed	160	163	Do not exceed this speed with windows open.

Figure 2-1. Airspeed Limitations

2-4 July 8/98

#### AIRSPEED INDICATOR MARKINGS

Airspeed indicator markings and their color code significance are shown in Figure 2-2.

MARKING	KIAS VALUE OR RANGE	SIGNIFICANCE
White Arc	40 - 85	Full Flap Operating Range. Lower limit is maximum weight V <sub>S0</sub> in landing configuration. Upper limit is maximum speed permissible with flaps extended.
Green Arc	48 -129	Normal Operating Range. Lower limit is maximum weight V <sub>S1</sub> at most forward C.G. with flaps retracted. Upper limit is maximum structural cruising speed.
Yellow Arc	129-163	Operations must be conducted with caution and only in smooth air.
Red Line	163	Maximum speed for all operations.

#### **POWERPLANT LIMITATIONS**

Engine Manufacturer: Textron Lycoming. Engine Model Number: IO-360-L2A. Maximum Power: 180 BHP rating.

Engine Operating Limits for Takeoff and Continuous Operations:

Maximum Engine Speed: 2700 RPM.

#### NOTE

The static RPM range at full throttle is 2300 - 2400 RPM.

245°F (118°C). Maximum Oil Temperature:

Oil Pressure, Minimum: Maximum: 20 PSI.

115 PSI.

Revision 4 2-5 Fuel Grade: See Fuel Limitations.

Oil Grade (Specification):

MIL-L-6082 or SAE J1966 Aviation Grade Straight Mineral Oil or MIL-L-22851 or SAE J1899 Ashless Dispersant Oil. Oil must comply with the latest revision and/or supplement for Textron Lycoming Service Instruction No. 1014.

Propeller Manufacturer: McCauley Propeller Systems.

Propeller Model Number: 1A170E/JHA7660.

Propeller Diameter: Maximum 76 inches.

Minimum: 75 inch minimum.

#### POWERPLANT INSTRUMENT MARKINGS

Powerplant instrument markings and their color code significance are shown in Figure 2-3.

INSTRUMENT	INSTRUMENT RED LINE (NORI OPER		RED LINE (MAX)
Tachometer: Sea Level 5000 Feet 10,000 Feet		2100 to 2500 RPM 2100 to 2600 RPM 2100 to 2700 RPM	2700
Oil Temperature		100 to 245°F	245°F
Oil Pressure	20 PSI	50 to 90 PSI	115 PSI
Fuel Quantity	0 (1.5 Gal. Unusable Each Tank)		
Fuel Flow		0 to 12 GPH	
Vacuum Gage		4.5 - 5.5 in.Hg	

Figure 2-3. Powerplant Instrument Markings

2-6 Revision 4

#### **WEIGHT LIMITS**

#### NORMAL CATEGORY

Maximum Ramp Weight: 2558 lbs. Maximum Takeoff Weight: 2550 lbs. Maximum Landing Weight: 2550 lbs.

Maximum Weight in Baggage Compartment: Baggage Area 1 - Station 82 to 108: 120 lbs. Baggage Area 2 - Station 108 to 142: 50 lbs.

#### NOTE

The maximum combined weight capacity for baggage areas 1 and 2 is 120 lbs.

#### **UTILITY CATEGORY**

Maximum Ramp Weight: 2208 lbs. Maximum Takeoff Weight: 2200 lbs. Maximum Landing Weight: 2200 lbs.

Maximum Weight in Baggage Compartment: In the utility category, the baggage compartment must be empty and rear seat must not be occupied.

#### **CENTER OF GRAVITY LIMITS**

#### **NORMAL CATEGORY**

Center of Gravity Range:

Forward: 35.0 inches aft of datum at 1950 lbs. or less, with

straight line variation to 41.0 inches aft of datum at

2550 lbs.

Aft: 47.3 inches aft of datum at all weights.

Reference Datum: Lower portion of front face of firewall.

Jul 8/98 2-7

#### **UTILITY CATEGORY**

Center of Gravity Range:

Forward: 35.0 inches aft of datum at 1950 lbs. or less, with

straight line variation to 37.5 inches aft of datum at

2200 lbs.

Aft: 40.5 inches aft of datum at all weights.

Reference Datum: Lower portion of front face of firewall.

#### MANEUVER LIMITS

#### **NORMAL CATEGORY**

This airplane is certificated in both the normal and utility category. The normal category is applicable to aircraft intended for non aerobatic operations. These include any maneuvers incidental to normal flying, stalls (except whip stalls), lazy eights, chandelles, and turns in which the angle of bank is not more than  $60^{\circ}$ .

### NORMAL CATEGORY MANEUVERS AND RECOMMENDED ENTRY SPEED\*

Chandelles	105 Knots
Lazy Eights	105 Knots
Steep Turns	95 Knots
Stalls (Except Whip Stalls) Slow	Deceleration

<sup>\*</sup> Abrupt use of the controls is prohibited above 105 KIAS.

2-8 Jul 8/98

#### **UTILITY CATEGORY**

This airplane is not designed for purely aerobatic flight. However, in the acquisition of various certificates such as commercial pilot and flight instructor, certain maneuvers are required by the FAA. All of these maneuvers are permitted in this airplane when operated in the utility category.

In the utility category, the rear seat must not be occupied and the baggage compartment must be empty.

### UTILITY CATEGORY MANEUVERS AND RECOMMENDED ENTRY SPEED\*

Chandelles	105 Knots
Lazy Eights	105 Knots
Steep Turns	
	w Deceleration
Stalls (Except Whip Stalls) Slo	w Deceleration

<sup>\*</sup> Abrupt use of the controls is prohibited above 98 knots.

Aerobatics that may impose high loads should not be attempted. The important thing to bear in mind in flight maneuvers is that the airplane is clean in aerodynamic design and will build up speed quickly with the nose down. Proper speed control is an essential requirement for execution of any maneuver, and care should always be exercised to avoid excessive speed which in turn can impose excessive loads. In the execution of all maneuvers, avoid abrupt use of controls.

Jul 8/98 2-9

#### FLIGHT LOAD FACTOR LIMITS

#### **NORMAL CATEGORY**

Flight Load Factors (Maximum Takeoff Weight	- 2550 lbs.):
*Flaps Up	+3.8g, -1.52g
*Flaps Down	+3.0g

\*The design load factors are 150% of the above, and in all cases, the structure meets or exceeds design loads.

#### **UTILITY CATEGORY**

Flight Load Factors (Maximum Takeoff Weight -	2200 lbs.):
*Flaps Up	+4.4g, -1.76g
*Flaps Down	+3.0g

\*The design load factors are 150% of the above, and in all cases, the structure meets or exceeds design loads.

#### KINDS OF OPERATION LIMITS

The airplane as delivered is equipped for day VFR and may be equipped for night VFR and/or IFR operations. FAR Part 91 establishes the minimum required instrumentation and equipment for these operations. The reference to types of flight operations on the operating limitations placard reflects equipment installed at the time of Airworthiness Certificate issuance.

Flight into known icing conditions is prohibited.

2-10 Revision 4

#### **FUEL LIMITATIONS**

Total Fuel: 56 U.S. gallons (2 tanks at 28.0 gallons each).

Usable Fuel (all flight conditions): 53.0 U.S. gallons.

Unusable Fuel: 3.0 U.S. gallons (1.5 gallons each tank).

#### NOTE

To ensure maximum fuel capacity and minimize cross-feeding when refueling, always park the airplane in a wings-level, normal ground attitude and place the fuel selector in the Left or Right position. Refer to Figure 1-1 for normal ground attitude definition.

#### ADDITIONAL FUEL LIMITATIONS

Takeoff and land with the fuel selector valve handle in the BOTH position.

Maximum slip or skid duration with one tank dry: 30 seconds.

Operation on either LEFT or RIGHT tank limited to level flight only.

With 1/4 tank or less, prolonged uncoordinated flight is prohibited when operating on either left or right tank.

Fuel remaining in the tank after the fuel quantity indicator reads 0 (red line) cannot be safely used in flight.

Approved Fuel Grades (and Colors):

100LL Grade Aviation Fuel (Blue). 100 Grade Aviation Fuel (Green).

#### **OTHER LIMITATIONS**

#### **FLAP LIMITATIONS**

Approved Takeoff Range:	 $0^\circ$ to $10^\circ$
Approved Landing Range:	 $0^\circ$ to $30^\circ$

Jul 8/98 2-11

#### **PLACARDS**

The following information must be displayed in the form of composite or individual placards.

1. In full view of the pilot: (The "DAY-NIGHT-VFR-IFR" entry, shown on the example below, will vary as the airplane is equipped).

The markings and placards installed in this airplane contain operating limitations which must be complied with when operating this airplane in the Normal Category. Other operating limitations which must be complied with when operating this airplane in this category or in the Utility Category are contained in the Pilot's Operating Handbook and FAA Approved Airplane Flight Manual.

Normal Category No acrobatic maneuvers, including spins,

approved.

Utility Category No acrobatic maneuvers approved,

except those listed in the Pilot's

Operating Handbook.

Baggage compartment and rear seat

must not be occupied.

Spin Recovery Opposite rudder - forward elevator -

neutralize controls.

Flight into known icing conditions prohibited.

This airplane is certified for the following flight operations as of

date of original airworthiness certificate:

DAY-NIGHT-VFR-IFR

2-12 Revision 4

#### 2. On the fuel selector valve:

	TAKEOFF LANDING	BOTH 53.0 GAL.	ALL FLIGHT ATTITUDES
		FUEL SELECT	
LEF <sup>-</sup> 26.5 GA LEVEL FLIGH ONLY	`. \L. - T		RIGHT 26.5 GAL. LEVEL FLIGHT ONLY

#### 3. Near fuel tank filler cap:

FUEL
100LL/100 MIN. GRADE AVIATION GASOLINE
CAP. 26.5 U.S. GAL. USABLE
CAP 17.5 U.S. GAL USABLE TO BOTTOM
OF FILLER INDICATOR TAB

#### 4. On flap control indicator:

0° to 10°	110 KIAS	(Partial flap range with blue color code; also, mechanical detent at 10°.)
10° to 30°	85 KIAS	(White color code; also, mechanical detent at 20°.)

Jul 8/98 2-13

5. In baggage compartment:

120 POUNDS MAXIMUM BAGGAGE FORWARD OF BAGGAGE DOOR LATCH

50 POUNDS MAXIMUM BAGGAGE AFT OF BAGGAGE DOOR LATCH

MAXIMUM 120 POUNDS COMBINED

FOR ADDITIONAL LOADING INSTRUCTIONS SEE WEIGHT AND BALANCE DATA

- 6. A calibration card must be provided to indicate the accuracy of the magnetic compass in 30° increments.
- 7. On the oil filler cap:

OIL 8 QTS

On control lock:

CAUTION!
CONTROL LOCK
REMOVE BEFORE STARTING ENGINE

9. Near airspeed indicator:

MANEUVERING SPEED - 105 KIAS

10. On the Upper Right Side of the Aft Cabin Partition:

EMERGENCY LOCATOR TRANSMITTER
INSTALLED AFT OF THIS PARTITION
MUST BE SERVICED IN ACCORDANCE
WITH FAR PART 91.207

11. On forward face of firewall adjacent to the battery:

CAUTION 24 VOLTS D.C.
THIS AIRCRAFT IS EQUIPPED WITH ALTERNATOR
AND A NEGATIVE GROUND SYSTEM.
OBSERVE PROPER POLARITY.
REVERSE POLARITY WILL DAMAGE ELECTRICAL
COMPONENTS.

12. On the upper right instrument panel:

**SMOKING PROHIBITED** 

### SECTION 3 EMERGENCY PROCEDURES

TABLE OF CONTENTS		
Introduction	3-3	
AIRSPEEDS		
Airspeeds For Emergency Operation	3-3	
EMERGENCY PROCEDURES CHECKLIST		
Engine Failures Engine Failure During Takeoff Roll Engine Failure Immediately After Takeoff Engine Failure During Flight (Restart Procedures)  Forced Landings Emergency Landing Without Engine Power Precautionary Landing With Engine Power Ditching  Fires During Start On Ground Engine Fire In Flight Electrical Fire In Flight Cabin Fire Wing Fire  Icing Inadvertent Icing Encounter Static Source Blockage	3-5 3-6 3-5 3-7 3-7 3-7 3-8 3-8 3-9 3-9 3-10	
Landing With A Flat Main Tire	3-10 3-10	

Revision 4

### **TABLE OF CONTENTS (Continued)**

	Page
Electrical Power Supply System Malfunctions	3-11
(Full Scale Deflection)	3-11
(Ammeter Indicates Discharge)	3-11
Vacuum System Failure	3-12
AMPLIFIED EMERGENCY PROCEDURES	
Engine Failure	3-13
Forced Landings	3-15
Landing Without Elevator Control	3-15
Fires	3-16
Emergency Operation In Clouds (Vacuum System Failure) .	3-16
Executing A 180° Turn In Clouds	3-16
Emergency Descent Through Clouds	3-17
Recovery From Spiral Dive In The Clouds	3-18
Inadvertent Flight Into Icing Conditions	3-18
Static Source Blocked	3-18
Spins	3-19
Rough Engine Operation Or Loss Of Power	3-20
Spark Plug Fouling	3-20
Magneto Malfunction	3-20
Engine-Driven Fuel Pump Failure	3-20
Excessive Fuel Vapor Indications	3-21
Low Oil Pressure	3-21
Electrical Power Supply System Malfunctions	3-22
Excessive Rate of Charge	3-22
Insufficient Rate Of Charge	3-23
Other Emergencies	3-23
Windshield Damage	3-23

3-2 Revision 4

#### INTRODUCTION

Section 3 provides checklist and amplified procedures for coping with emergencies that may occur. Emergencies caused by airplane or engine malfunctions are extremely rare if proper preflight inspections and maintenance are practiced. Enroute weather emergencies can be minimized or eliminated by careful flight planning and good judgment when unexpected weather is encountered. However, should an emergency arise, the basic guidelines described in this section should be considered and applied as necessary to correct the problem. Emergency procedures associated with standard avionics, the ELT, or any optional systems can be found in the Supplements, Section 9.

#### **AIRSPEEDS**

#### AIRSPEEDS FOR EMERGENCY OPERATION

Engine Failure After Takeoff:	
Wing Flaps Up	70 KIAS
Wing Flaps Down	65 KIAS
Maneuvering Speed:	
2550 Lbs	105 KIAS
2200 Lbs	98 KIAS
1900 Lbs	90 KIAS
Maximum Glide	68 KIAS
Precautionary Landing With Engine Power	65 KIAS
Landing Without Engine Power:	
Wing Flaps Up	70 KIAS
Wing Flaps Down	65 KIAS

May 30/00 3-3

#### **EMERGENCY PROCEDURES CHECKLIST**

Procedures in the Emergency Procedures Checklist portion of this section shown in **bold faced** type are immediate action items which should be committed to memory.

#### **ENGINE FAILURES**

#### ENGINE FAILURE DURING TAKEOFF ROLL

- 1. Throttle -- IDLE.
- 2. Brakes-- APPLY.
- 3. Wing Flaps -- RETRACT.
- 4. Mixture -- IDLE CUT OFF.
- 5. Ignition Switch -- OFF.
- 6. Master Switch -- OFF.

#### ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

- 1. Airspeed -- 70 KIAS (flaps UP). 65 KIAS (flaps DOWN).
- 2. Mixture -- IDLE CUT OFF.
- 3. Fuel Shutoff Valve -- OFF (Pull Full Out).
- 4. Ignition Switch -- OFF.
- 5. Wing Flaps -- AS REQUIRED.
- 6. Master Switch -- OFF.
- 7. Cabin Door -- UNLATCH.
- 8. Land -- STRAIGHT AHEAD.

3-4 Revision 4

#### **ENGINE FAILURE DURING FLIGHT (Restart Procedures)**

- 1. Airspeed -- 68 KIAS.
- 2. Fuel Shutoff Valve -- ON (push full in).
- 3. Fuel Selector Valve -- BOTH.
- 4. Auxiliary Fuel Pump Switch -- ON.
- 5. Mixture -- RICH (if restart has not occurred).
- 6. Ignition Switch -- BOTH (or START if propeller is stopped).

#### NOTE

If the propeller is windmilling, the engine will restart automatically within a few seconds. If the propeller has stopped (possible at low speeds), turn the ignition switch to START, advance the throttle slowly from idle and lean the mixture from full rich as required for smooth operation.

7. Auxiliary Fuel Pump Switch -- OFF.

#### NOTE

If the fuel flow indicator immediately drops to zero (indicating an engine-driven fuel pump failure), return the Auxiliary Fuel Pump Switch to the ON position.

#### **FORCED LANDINGS**

#### EMERGENCY LANDING WITHOUT ENGINE POWER

- Passenger Seat Backs -- MOST UPRIGHT POSITION.
- 2. Seats and Seat Belts -- SECURE.
- Airspeed -- 70 KIAS (flaps UP).
   65 KIAS (flaps DOWN).
- 4. Mixture -- IDLE CUT OFF.
- 5. Fuel Shutoff Valve -- OFF (Pull Full Out).
- 6. Ignition Switch -- OFF.
- 7. Wing Flaps -- AS REQUIRED (30° recommended).
- 8. Master Switch -- OFF (when landing is assured).
- 9. Doors -- UNLATCH PRIOR TO TOUCHDOWN.
- 10. Touchdown -- SLIGHTLY TAIL LOW.
- 11. Brakes -- APPLY HEAVILY.

#### PRECAUTIONARY LANDING WITH ENGINE POWER

- 1. Passenger Seat Backs -- MOST UPRIGHT POSITION.
- 2. Seats and Seat Belts -- SECURE.
- 3. Airspeed -- 65 KIAS.
- 4. Wing Flaps -- 20°.
- 5. Selected Field -- FLY OVER, noting terrain and obstructions, then retract flaps upon reaching a safe altitude and airspeed.
- 6. Avionics Master Switch and Electrical Switches -- OFF.
- 7. Wing Flaps -- 30° (on final approach).
- 8. Airspeed -- 65 KIAS.
- 9. Master Switch -- OFF.
- 10. Doors -- UNLATCH PRIOR TO TOUCHDOWN.
- 11. Touchdown -- SLIGHTLY TAIL LOW.
- 12. Ignition Switch -- OFF.
- 13. Brakes -- APPLY HEAVILY.

#### **DITCHING**

- 1. Radio -- TRANSMIT MAYDAY on 121.5 MHz, giving location and intentions and SQUAWK 7700.
- Heavy Objects (in baggage area) -- SECURE OR JETTISON (if possible).
- 3. Passenger Seat Backs -- MOST UPRIGHT POSITION.
- 4. Seats and Seat Belts -- SECURE.
- 5. Wing Flaps -- 20° to 30°.
- 6. Power -- ESTABLISH 300 FT/MIN DESCENT AT 55 KIAS.

#### NOTE

If no power is available, approach at 70 KIAS with flaps up or at 65 KIAS with 10° flaps.

- 7. Approach -- High Winds, Heavy Seas -- INTO THE WIND. Light Winds, Heavy Swells -- PARALLEL TO SWELLS.
- 8. Cabin Doors -- UNLATCH.
- Touchdown -- LEVEL ATTITUDE AT ESTABLISHED RATE OF DESCENT.
- 10. Face -- CUSHION at touchdown with folded coat.
- 11. ELT -- Activate.
- 12. Airplane -- EVACUATE through cabin doors. If necessary, open window and flood cabin to equalize pressure so doors can be opened.
- 13. Life Vests and Raft -- INFLATE WHEN CLEAR OF AIRPLANE.

3-6 Revision 4

#### **FIRES**

#### **DURING START ON GROUND**

Ignition Switch -- START, Continue Cranking to get a start
 which would suck the flames and accumulated fuel into the
 engine.

#### If engine starts:

- 2. Power -- 1800 RPM for a few minutes.
- 3. Engine -- SHUTDOWN and inspect for damage.

#### If engine fails to start:

- 4. Throttle -- FULL OPEN.
- 5. Mixture -- IDLE CUT OFF.
- 6. Cranking -- CONTINUE.
- 7. Fuel Shutoff Valve -- OFF (Pull Full Out).
- 8. Auxiliary Fuel Pump Switch -- OFF.
- 9. Fire Extinguisher -- ACTIVATE.
- 10. Engine -- SECURE.
  - a. Master Switch -- OFF.
  - b. Ignition Switch -- OFF
- 11. Parking Brake -- RELEASE.
- 12. Airplane -- EVACUATE.
- Fire -- EXTINGUISH using fire extinguisher, wool blanket, or dirt.
- Fire Damage -- INSPECT, repair damage or replace damaged components or wiring before conducting another flight.

#### **ENGINE FIRE IN FLIGHT**

- 1. Mixture -- IDLE CUT OFF.
- 2. Fuel Shutoff Valve -- Pull Out (OFF).
- 3. Auxiliary Fuel Pump Switch -- OFF.
- 4. Master Switch -- OFF.
- 5. Cabin Heat and Air -- OFF (except overhead vents).
- 6. Airspeed -- 100 KIAS (If fire is not extinguished, increase glide speed to find an airspeed within airspeed limitations which will provide an incombustible mixture).
- 7. Forced Landing -- EXECUTE (as described in Emergency Landing Without Engine Power).

#### **ELECTRICAL FIRE IN FLIGHT**

- 1. Master Switch -- OFF.
- 2. Vents, Cabin Air, Heat -- CLOSED.
- 3. Fire Extinguisher -- ACTIVATE.
- 4. Avionics Master Switch -- OFF.
- 5. All Other Switches (except ignition switch) -- OFF.

#### **A** WARNING

# AFTER DISCHARGING FIRE EXTINGUISHER AND ASCERTAINING THAT FIRE HAS BEEN EXTINGUISHED, VENTILATE THE CABIN.

6. Vents/Cabin Air/Heat -- OPEN when it is ascertained that fire is completely extinguished.

If fire has been extinguished and electrical power is necessary for continuance of flight to nearest suitable airport or landing area:

- 7. Master Switch -- ON.
- 8. Circuit Breakers -- CHECK for faulty circuit, do not reset.
- 9. Radio Switches -- OFF.
- Avionics Master Switch -- ON.
- Radio/Electrical Switches -- ON one at a time, with delay after each until short circuit is localized.

#### **CABIN FIRE**

- 1. Master Switch -- OFF.
- Vents/Cabin Air/Heat -- CLOSED (to avoid drafts).
- 3. Fire Extinguisher -- ACTIVATE.

#### **WARNING**

# AFTER DISCHARGING FIRE EXTINGUISHER AND ASCERTAINING THAT FIRE HAS BEEN EXTINGUISHED, VENTILATE THE CABIN.

- 4. Vents/Cabin Air/Heat -- Open when it is ascertained that fire is completely extinguished.
- 5. Land the airplane as soon as possible to inspect for damage.

3-8 Revision 4

#### WING FIRE

- 1. Landing/Taxi Light Switches -- OFF.
- 2. Navigation Light Switch -- OFF.
- 3. Strobe Light Switch -- OFF.
- 4. Pitot Heat Switch -- OFF.

#### NOTE

Perform a sideslip to keep the flames away from the fuel tank and cabin. Land as soon as possible using flaps only as required for final approach and touchdown.

#### **ICING**

ı

#### INADVERTENT ICING ENCOUNTER

- 1. Turn pitot heat switch ON.
- 2. **Turn back or change altitude** to obtain an outside air temperature that is less conducive to icing.
- Pull cabin heat control full out and open defroster outlets to obtain maximum windshield defroster airflow. Adjust cabin air control to get maximum defroster heat and airflow.
- 4. Watch for signs of engine-related icing conditions. An unexplained loss in engine speed could be caused by ice blocking the air intake filter, or, in extremely rare instances, ice completely blocking the fuel injection air reference tubes. Change the throttle position to obtain maximum RPM. This may require either advancing or retarding the throttle, dependent on where ice has accumulated in the system. Adjust mixture, as required, for maximum RPM.
- 5. Plan a landing at the nearest airport. With an extremely rapid ice build up, select a suitable "off airport" landing site.
- 6. With an ice accumulation of 1/4 inch or more on the wing leading edges, be prepared for significantly higher stall speed and a longer landing roll.
- Leave wing flaps retracted. With a severe ice build up on the horizontal tail, the change in wing wake airflow direction caused by wing flap extension could result in a loss of elevator effectiveness.
- 8. Open left window and, if practical, scrape ice from a portion of the windshield for visibility in the landing approach.
- Perform a landing approach using a forward slip, if necessary, for improved visibility.

- Approach at 65 to 75 KIAS depending upon the amount of the accumulation.
- 11. Perform a landing in level attitude.

## STATIC SOURCE BLOCKAGE (Erroneous Instrument Reading Suspected)

- 1. Static Pressure Alternate Source Valve -- PULL ON.
- 2. Airspeed -- Consult appropriate calibration tables in Section 5.

#### LANDING WITH A FLAT MAIN TIRE

- 1. Approach -- NORMAL.
- 2. Wing Flaps -- 30°.
- 3. Touchdown -- GOOD MAIN TIRE FIRST, hold airplane off flat tire as long as possible with aileron control.
- 4. Directional Control -- MAINTAIN using brake on good wheel as required.

#### LANDING WITH A FLAT NOSE TIRE

- 1. Approach -- NORMAL.
- 2. Flaps -- AS REQUIRED.
- 3. Touchdown -- ON MAINS, hold nose wheel off the ground as long as possible.
- 4. When nose wheel touches down, maintain full up elevator as airplane slows to stop.

3-10 May 30/00

## ELECTRICAL POWER SUPPLY SYSTEM MALFUNCTIONS

## AMMETER SHOWS EXCESSIVE RATE OF CHARGE (Full Scale Deflection)

1. Alternator -- OFF.

#### **A** CAUTION

WITH THE ALTERNATOR SIDE OF THE MASTER SWITCH OFF, COMPASS DEVIATIONS OF AS MUCH AS 25° MAY OCCUR.

- 2. Nonessential Electrical Equipment -- OFF.
- 3. Flight -- TERMINATE as soon as practical.

## LOW VOLTAGE ANNUNCIATOR (VOLTS) ILLUMINATES DURING FLIGHT (Ammeter Indicates Discharge)

#### NOTE

Illumination of "VOLTS" on the annunciator panel may occur during low RPM conditions with an electrical load on the system such as during a low RPM taxi. Under these conditions, the annunciator will go out at higher RPM. The master switch need not be recycled since an overvoltage condition has not occurred to deactivate the alternator system.

- 1. Avionics Master Switch -- OFF.
- 2. Alternator Circuit Breaker (ALT FLD) -- CHECK IN.
- 3. Master Switch -- OFF (both sides).
- 4. Master Switch -- ON.
- 5. Low Voltage Annunciator (VOLTS) -- CHECK OFF.
- 6. Avionics Master Switch -- ON.

If low voltage annunciator (VOLTS) illuminates again:

- 7. Alternator -- OFF.
- 8. Nonessential Radio and Electrical Equipment -- OFF.
- 9. Flight -- TERMINATE as soon as practical.

#### **VACUUM SYSTEM FAILURE**

Left Vacuum (L VAC) Annunciator or Right Vacuum (VAC R) Annunciator Illuminates.

#### **A** CAUTION

IF VACUUM IS NOT WITHIN NORMAL OPERATING LIMITS, A FAILURE HAS OCCURRED IN THE VACUUM SYSTEM AND PARTIAL PANEL PROCEDURES MAY BE REQUIRED FOR CONTINUED FLIGHT.

1. Vacuum Gage -- CHECK to ensure vacuum within normal operating limits.

3-12 Revision 4

# AMPLIFIED EMERGENCY PROCEDURES

The following Amplified Emergency Procedures elaborate upon information contained in the Emergency Procedures Checklists portion of this section. These procedures also include information not readily adaptable to a checklist format, and material to which a pilot could not be expected to refer in resolution of a specific emergency. This information should be reviewed in detail prior to flying the airplane, as well as reviewed on a regular basis to keep pilot's knowledge of procedures fresh.

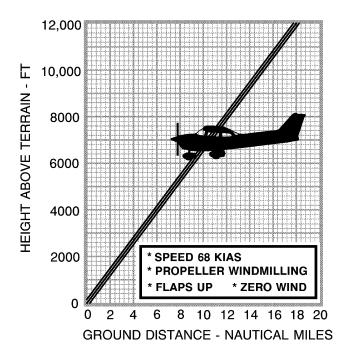
#### **ENGINE FAILURE**

If an engine failure occurs during the takeoff roll, the most important thing to do is stop the airplane on the remaining runway. Those extra items on the checklist will provide added safety after a failure of this type.

Prompt lowering of the nose to maintain airspeed and establish a glide attitude is the first response to an engine failure after takeoff. In most cases, the landing should be planned straight ahead with only small changes in direction to avoid obstructions. Altitude and airspeed are seldom sufficient to execute a 180° gliding turn necessary to return to the runway. The checklist procedures assume that adequate time exists to secure the fuel and ignition systems prior to touchdown.

July 8/98 3-13

After an engine failure in flight, the most important course of action is to continue flying the airplane. Best glide speed as shown in Figure 3-1 should be established as quickly as possible. While gliding toward a suitable landing area, an effort should be made to identify the cause of the failure. If time permits, an engine restart should be attempted as shown in the checklist. If the engine cannot be restarted, a forced landing without power must be completed.



0585C1011

Figure 3-1. Maximum Glide

#### FORCED LANDINGS

If all attempts to restart the engine fail and a forced landing is imminent, select a suitable field and prepare for the landing as discussed under the Emergency Landing Without Engine Power checklist. Transmit Mayday message on 121.5 MHz giving location and intentions and squawk 7700.

Before attempting an "off airport" landing with engine power available, one should fly over the landing area at a safe but low altitude to inspect the terrain for obstructions and surface conditions, proceeding as discussed under the Precautionary Landing With Engine Power checklist.

Prepare for ditching by securing or jettisoning heavy objects located in the baggage area and collect folded coats for protection of occupants' face at touchdown. Transmit Mayday message on 121.5 MHz giving location and intentions and squawk 7700. Avoid a landing flare because of difficulty in judging height over a water surface. The checklist assumes the availability of power to make a precautionary water landing. If power is not available, use of the airspeeds noted with minimum flap extension will provide a more favorable attitude for a power off ditching.

In a forced landing situation, do not set the AVIONICS MASTER switch or the airplane MASTER switch to the OFF position until a landing is assured. When these switches are in the OFF position, the airplane electrical systems are de-energized.

Before performing a forced landing, especially in remote and mountainous areas, activate the ELT transmitter by positioning the cockpit-mounted switch to the ON position. For complete information on ELT operation, refer to the Supplements, Section 9.

#### LANDING WITHOUT ELEVATOR CONTROL

Trim for horizontal flight (with an airspeed of approximately 65 KIAS and flaps set to 20°) by using throttle and elevator trim controls. Then **do not change the elevator trim control setting**; control the glide angle by adjusting power exclusively.

At the landing flare (round-out), the nose down moment resulting from power reduction is an adverse factor and the airplane may land on the nose wheel. Consequently, at flare, the elevator trim control should be adjusted toward the full nose up position and the power adjusted so that the airplane will rotate to the horizontal attitude for touchdown. Close the throttle at touchdown.

#### **FIRES**

Although engine fires are extremely rare in flight, the steps of the appropriate checklist should be followed if one is encountered. After completion of this procedure, execute a forced landing. Do not attempt to restart the engine.

The initial indication of an electrical fire is usually the odor of burning insulation. The checklist for this problem should result in elimination of the fire.

# **EMERGENCY OPERATION IN CLOUDS** (Total Vacuum System Failure)

If both the vacuum pumps fail in flight, the directional indicator and attitude indicator will be disabled, and the pilot will have to rely on the turn coordinator if he inadvertently flies into clouds. If an autopilot is installed, it too may be affected. Refer to Section 9, Supplements, for additional details concerning autopilot operation. The following instructions assume that only the electrically powered turn coordinator is operative, and that the pilot is not completely proficient in instrument flying.

#### **EXECUTING A 180° TURN IN CLOUDS**

Upon inadvertently entering the clouds, an immediate plan should be made to turn back as follows:

1. Note the compass heading.

2. Using the clock, initiate a standard rate left turn, holding the turn coordinator symbolic airplane wing opposite the lower left index mark for 60 seconds. Then roll back to level flight by leveling the miniature airplane.

3-16 Revision 4

- 3. Check accuracy of the turn by observing the compass heading which should be the reciprocal of the original heading.
- 4. If necessary, adjust heading primarily with skidding motions rather than rolling motions so that the compass will read more accurately.
- 5. Maintain altitude and airspeed by cautious application of elevator control. Avoid over controlling by keeping the hands off the control wheel as much as possible and steering only with rudder.

#### **EMERGENCY DESCENT THROUGH CLOUDS**

If conditions prevent return to VFR flight by a 180° turn, all descent through a cloud deck to VFR conditions may be appropriate. If possible, obtain radio clearance for an emergency descent through clouds. To guard against a spiral dive, choose an easterly or westerly heading to minimize compass card swings due to changing bank angles. In addition, keep hands off the control wheel and steer a straight course with rudder control by monitoring the turn coordinator. Occasionally check the compass heading and make minor corrections to hold an approximate course. Before descending into the clouds, set up a stabilized letdown condition as follows:

- 1. Apply full rich mixture.
- 2. Reduce power to set up a 500 to 800 ft/min rate of descent.
- 3. Adjust the elevator trim for a stabilized descent at 70-80 KIAS.
- 4. Keep hands off the control wheel.
- 5. Monitor turn coordinator and make corrections by rudder alone.
- 6. Check trend of compass card movement and make cautious corrections with rudder to stop the turn.
- 7. Upon breaking out of clouds, resume normal cruising flight.

#### RECOVERY FROM SPIRAL DIVE IN THE CLOUDS

If a spiral is encountered in the clouds, proceed as follows:

- 1. Retard throttle to idle position.
- 2. Stop the turn by using coordinated aileron and rudder control to align the symbolic airplane in the turn coordinator with the horizon reference line.
- 3. Cautiously apply elevator back pressure to slowly reduce the airspeed to 80 KIAS.
- 4. Adjust the elevator trim control to maintain an 80 KIAS glide.
- Keep hands off the control wheel, using rudder control to hold a straight heading.
- 6. Clear engine occasionally, but avoid using enough power to disturb the trimmed glide.
- 7. Upon breaking out of clouds, resume normal cruising flight.

#### **INADVERTENT FLIGHT INTO ICING CONDITIONS**

Flight into icing conditions is **prohibited** and extremely dangerous. An inadvertent encounter with these conditions can best be handled using the checklist procedures. The best procedure, of course, is to turn back or change altitude to escape icing conditions.

During these encounters, an unexplained loss in engine speed could be caused by ice blocking the air intake filter, or, in extremely rare instances, ice completely blocking the fuel injection air reference tubes. In either case, the throttle should be positioned to obtain maximum RPM (in some instances, the throttle may need to be retarded for maximum power). The mixture should then be adjusted, as required, to obtain maximum RPM.

#### STATIC SOURCE BLOCKED

If erroneous readings of the static source instruments (airspeed, altimeter and vertical speed) are suspected, the static pressure alternate source valve should be pulled ON, thereby supplying static pressure to these instruments from the cabin.

3-18 Revision 4

When using the alternate static source, refer to the Alternate Static Source Airspeed Calibration table in Section 5, Performance, for additional information.

Maximum airspeed and altimeter variation from normal is 4 knots and 30 feet over the normal operating range with the window(s) closed. See Section 5, Performance, for additional airspeed calibration data.

#### **SPINS**

Should an inadvertent spin occur, the following recovery procedure should be used:

- 1. RETARD THROTTLE TO IDLE POSITION.
- 2. PLACE AILERONS IN NEUTRAL POSITION.
- APPLY AND HOLD FULL RUDDER OPPOSITE TO THE DIRECTION OF ROTATION.
- 4. JUST AFTER THE RUDDER REACHES THE STOP, MOVE THE CONTROL WHEEL BRISKLY FORWARD FAR ENOUGH TO BREAK THE STALL. Full down elevator may be required at aft center of gravity loadings to assure optimum recoveries.
- HOLD THESE CONTROL INPUTS UNTIL ROTATION STOPS. Premature relaxation of the control inputs may extend the recovery.
- AS ROTATION STOPS, NEUTRALIZE RUDDER, AND MAKE A SMOOTH RECOVERY FROM THE RESULTING DIVE.

#### NOTE

If disorientation precludes a visual determination of the direction of rotation, the symbolic airplane in the turn coordinator may be referred to for this information.

For additional information on spins and spin recovery, see the discussion under SPINS in Normal Procedures (Section 4).

# ROUGH ENGINE OPERATION OR LOSS OF POWER

#### SPARK PLUG FOULING

A slight engine roughness in flight may be caused by one or more spark plugs becoming fouled by carbon or lead deposits. This may be verified by turning the ignition switch momentarily from BOTH to either L or R position. An obvious power loss in single ignition operation is evidence of spark plug or magneto trouble. Assuming that spark plugs are the more likely cause, lean the mixture to the recommended lean setting for cruising flight. If the problem does not clear up in several minutes, determine if a richer mixture setting will produce smoother operation. If not, proceed to the nearest airport for repairs using the BOTH position of the ignition switch unless extreme roughness dictates the use of a single ignition position.

#### MAGNETO MALFUNCTION

A sudden engine roughness or misfiring is usually evidence of magneto problems. Switching from BOTH to either L or R ignition switch position will identify which magneto is malfunctioning. Select different power settings and enrichen the mixture to determine if continued operation on BOTH magnetos is possible. If not, switch to the good magneto and proceed to the nearest airport for repairs.

#### IENGINE-DRIVEN FUEL PUMP FAILURE

Failure of the engine-driven fuel pump will result in an immediate loss of engine power, similar to fuel exhaustion or starvation, but while operating from a fuel tank containing adequate fuel. A sudden reduction in indicated fuel flow will occur just before loss of engine power.

If the engine-driven fuel pump fails, immediately set the auxiliary fuel pump switch (FUEL PUMP) to the ON position to restore engine power. The flight should be terminated as soon as practical and the engine-driven fuel pump repaired.

3-20 Revision 4

#### **EXCESSIVE FUEL VAPOR INDICATIONS**

Excessive fuel vapor is most likely to be generated during ground operations when operating at higher altitudes, in unusually warm temperatures or with more volatile fuel blends. Operation at or near idle RPM (low fuel flow) for extended periods will increase the chances of fuel vapor generation. (See "Leaning For Ground Operations", Section 4.)

Indicated fuel flow that is not stable (sudden changes greater than 1 gal/hr) is a sign that fuel vapor may be present in the system. Fuel flow indications that become less stable (increasing changes) may lead to power surges and power loss if not corrected.

If in-flight vapor is suspected, smoother engine operation may result from making the following changes (singly or together): set the auxiliary fuel pump to the ON position, lean the mixture for smooth engine operation and select another fuel tank. Increasing the airspeed to provide more air flow through the cowling will aid in cooling the engine and fuel system components.

#### LOW OIL PRESSURE

If the low oil pressure annunciator (OIL PRESS) illuminates and oil temperature remains normal, the oil pressure sending unit or relief valve may be malfunctioning. Land at the nearest airport to inspect the source of trouble.

If a total loss of oil pressure is accompanied by a rise in oil temperature, there is good reason to suspect an engine failure is imminent. Reduce engine power immediately and select a suitable forced landing field. Use only the minimum power required to reach the desired touchdown spot.

# ELECTRICAL POWER SUPPLY SYSTEM MALFUNCTIONS

Malfunctions in the electrical power supply system can be detected by periodic monitoring of the ammeter and low voltage annunciator (VOLTS); however, the cause of these malfunctions is usually difficult to determine. A broken alternator drive belt or wiring is most likely the cause of alternator failures, although other factors could cause the problem. A defective alternator control unit can also cause malfunctions. Problems of this nature constitute an electrical emergency and should be dealt with immediately. Electrical power malfunctions usually fall into two categories: excessive rate of charge and insufficient rate of charge. The following paragraphs describe the recommended remedy for each situation.

#### **EXCESSIVE RATE OF CHARGE**

After engine starting and heavy electrical usage at low engine speeds (such as extended taxiing) the battery condition will be low enough to accept above normal charging during the initial part of a flight. However, after thirty minutes of cruising flight, the ammeter should be indicating less than two needle widths of charging current. If the charging rate were to remain above this value on a long flight, the battery would overheat and evaporate the electrolyte at an excessive rate.

Electronic components in the electrical system can be adversely affected by higher than normal voltage. The alternator control unit includes an overvoltage sensor which normally will automatically shut down the alternator if the charge voltage reaches approximately 31.5 volts. If the overvoltage sensor malfunctions, as evidenced by an excessive rate of charge shown on the ammeter, the alternator should be turned off, nonessential electrical equipment turned off and the flight terminated as soon as practical.

3-22 Revision 4

#### INSUFFICIENT RATE OF CHARGE

#### NOTE

The low voltage annunciator (VOLTS) may come on and ammeter discharge indications may occur during low RPM conditions with an electrical load on the system, such as during a low RPM taxi. Under these conditions, the annunciator will go out at higher RPM.

If the overvoltage sensor should shut down the alternator and trip the alternator circuit breaker (ALT FLD), or if the alternator output is low, a discharge rate will be shown on the ammeter followed by illumination of the low voltage annunciator (VOLTS). Since this may be a "nuisance" trip out, an attempt should be made to reactivate the alternator system. To reactivate, set the avionics master switch to the OFF position, check that the alternator circuit breaker (ALT FLD) is in, then set both sides of the master switch to the OFF position and then to the ON position. If the problem no longer exists, normal alternator charging will resume and the low voltage annunciator (VOLTS) will go off. The avionics master switch may then be returned to the ON position.

If the annunciator illuminates again, a malfunction is confirmed. In this event, the flight should be terminated and/or the current drain on the battery minimized because the battery can supply the electrical system for only a limited period of time. Battery power must be conserved for later operation of the wing flaps and, if the emergency occurs at night, for possible use of the landing lights during landing.

### OTHER EMERGENCIES

#### WINDSHIELD DAMAGE

If a bird strike or other incident should damage the windshield in flight to the point of creating an opening, a significant loss in performance may be expected. This loss may be minimized in some cases (depending on amount of damage, altitude, etc.) by opening the side windows while the airplane is maneuvered for a landing at the nearest airport. If airplane performance or other adverse conditions preclude landing at an airport, prepare for an "off airport" landing in accordance with the Precautionary Landing With Engine Power or Ditching checklists.

Revision 4 3-23/3-24

# SECTION 4 NORMAL PROCEDURES

TABLE OF CONTENTS	Page
Introduction	4-5
AIRSPEEDS	
Airspeeds For Normal Operation	4-5
CHECKLIST PROCEDURES	
Preflight Inspection	4-7
Cabin	4-7
Empennage	4-8
Right Wing, Trailing Edge	4-8
Right Wing	4-8
Nose	4-9
Left Wing	4-10
Left Wing, Leading Edge	4-11
Left Wing, Trailing Edge	4-11
Before Starting Engine	4-11
Starting Engine (With Battery)	4-12
Starting Engine (With External Power)	4-13
Before Takeoff	4-15
Takeoff	4-15
Normal Takeoff	4-15
Short Field Takeoff	4-16
Enroute Climb	4-16
Cruise	4-16
Descent	4-16
Before Landing	4-16

# **TABLE OF CONTENTS (Continued)**

	Page
Landing	4-17
Normal Landing	4-17
Short Field Landing	4-17
Balked Landing	4-17
After Landing	4-17
Securing Airplane	4-17
AMPLIFIED PROCEDURES	
Preflight Inspection	4-18
Starting Engine	4-19
Recommended Starter Duty Cycle	4-20
Leaning For Ground Operations	4-21
Taxiing	4-21
Before Takeoff	4-23
Warm Up	4-23
Magneto Check	4-23
Alternator Check	4-23
Landing Lights	4-24
Takeoff	4-24
Power Check	4-24
Wing Flap Settings	4-25
Crosswind Takeoff	4-25
Enroute Climb	4-25
Cruise	4-26
Leaning With an EGT Indicator	4-27
Fuel Savings Procedures for Flight Training Operations	4-28
Fuel Vapor Procedures	4-29
Stalls	4-30
Spins	4-30
Closed Throttle Engine Operating (Idling) During Flight	4-32

4-2 Revision 4

# **TABLE OF CONTENTS (Continued)**

	Page
Landing	4-33
Normal Landing	4-33
Short Field Landing	4-33
Crosswind Landing	4-34
Balked Landing	4-34
Cold Weather Operation	4-34
Winterization Kit	4-36
Hot Weather Operation	4-36
Noise Characteristics And Noise Reduction	4-36

Revision 4 4-3/4-4

### INTRODUCTION

Section 4 provides checklist and amplified procedures for the conduct of normal operation. Normal procedures associated with optional systems can be found in the Supplements, Section 9.

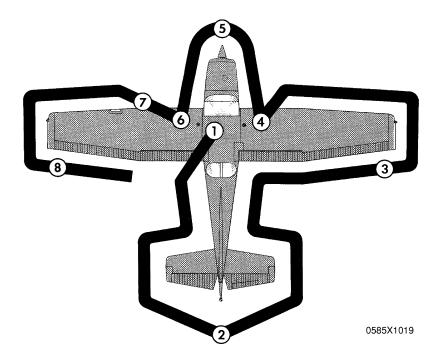
#### **AIRSPEEDS**

#### AIRSPEEDS FOR NORMAL OPERATION

Unless otherwise noted, the following speeds are based on a maximum weight of 2550 pounds and may be used for any lesser weight.

Takeoff:	
Normal Climb Out	75-85 KIAS
Short Field Takeoff, Flaps 10°, Speed at 50 Feet	. 56 KIAS
Enroute Climb, Flaps Up:	
Normal, Sea Level	75-85 KIAS
Normal, 10,000 Feet	70-80 KIAS
Best Rate-of-Climb, Sea Level	74 KIAS
Best Rate-of-Climb, 10,000 Feet	72 KIAS
Best Angle-of-Climb, Sea Level	62 KIAS
Best Angle-of-Climb, 10,000 Feet	67 KIAS
Landing Approach:	
Normal Approach, Flaps Up	65-75 KIAS
Normal Approach, Flaps 30°	60-70 KIAS
Short Field Approach, Flaps 30°	61 KIAS
Balked Landing:	
Maximum Power, Flaps 20°	60 KIAS
Maximum Recommended Turbulent Air Penetration Spee	d:
2550 Lbs	105 KIAS
2200 Lbs	98 KIAS
1900 Lbs	90 KIAS
Maximum Demonstrated Crosswind Velocity:	
Takeoff or Landing	15 KNOTS

May 30/00 4-5



#### NOTE

Visually check airplane for general condition during walkaround inspection. Airplane should be parked in a normal ground attitude (refer to Figure 1-1) to ensure that fuel drain valves allow for accurate sampling. Use of the refueling steps and assist handles will simplify access to the upper wing surfaces for visual checks and refueling operations. In cold weather, remove even accumulations of frost, ice or snow from wing, tail and control surfaces. Also, make sure that control surfaces contain no internal accumulations of ice or debris. Prior to flight, check that pitot heater is warm to touch within 30 seconds with battery and pitot heat switches on. If a night flight is planned, check operation of all lights, and make sure a flashlight is available.

Figure 4-1. Preflight Inspection

4-6 May 30/00

#### **CHECKLIST PROCEDURES**

#### PREFLIGHT INSPECTION

# (1) CABIN

- 1. Pitot Tube Cover -- REMOVE. Check for pitot blockage.
- 2. Pilot's Operating Handbook -- AVAILABLE IN THE AIRPLANE.
- 3. Airplane Weight and Balance -- CHECKED.
- 4. Parking Brake -- SET.
- 5. Control Wheel Lock -- REMOVE.
- 6. Ignition Switch -- OFF.
- 7. Avionics Master Switch -- OFF.

# **A** WARNING

WHEN TURNING ON THE MASTER SWITCH, USING AN EXTERNAL POWER SOURCE, OR PULLING THE PROPELLER THROUGH BY HAND, TREAT THE PROPELLER AS IF THE IGNITION SWITCH WERE ON. DO NOT STAND, NOR ALLOW ANYONE ELSE TO STAND, WITHIN THE ARC OF THE PROPELLER, SINCE A LOOSE OR BROKEN WIRE OR A COMPONENT MALFUNCTION COULD CAUSE THE PROPELLER TO ROTATE.

- 8. Master Switch -- ON.
- Fuel Quantity Indicators -- CHECK QUANTITY and ENSURE LOW FUEL ANNUNCIATORS (L LOW FUEL R) ARE EXTINGUISHED.
- Avionics Master Switch -- ON.
- 11. Avionics Cooling Fan -- CHECK AUDIBLY FOR OPERATION.
- Avionics Master Switch -- OFF.
- Static Pressure Alternate Source Valve -- OFF.
- 14. Annunciator Panel Switch -- PLACE AND HOLD IN TST POSITION and ensure all annunciators illuminate.

15. Annunciator Panel Test Switch -- RELEASE. Check that appropriate annunciators remain on.

#### NOTE

When Master Switch is turned ON, some annunciators will flash for approximately 10 seconds before illuminating steadily. When panel TST switch is toggled up and held in position, all remaining lights will flash until the switch is released.

- 16. Fuel Selector Valve -- BOTH.
- 17. Fuel Shutoff Valve -- ON (Push Full In).
- 18. Flaps -- EXTEND.
- 19. Pitot Heat -- ON. (Carefully check that pitot tube is warm to touch within 30 seconds.)
- 20. Pitot Heat -- OFF.
- 21. Master Switch -- OFF.
- 22. Elevator Trim -- SET for takeoff.
- 23. Baggage Door -- CHECK, lock with key.
- 24. Autopilot Static Source Opening (if installed) -- CHECK for blockage.

# 2 EMPENNAGE

- 1. Rudder Gust Lock (if installed) -- REMOVE.
- Tail Tie-Down -- DISCONNECT.
- Control Surfaces -- CHECK freedom of movement and security.
- 4. Trim Tab -- CHECK security.
- 5. Antennas -- CHECK for security of attachment and general condition.

# (3) RIGHT WING Trailing Edge

- 1. Aileron -- CHECK freedom of movement and security.
- 2. Flap -- CHECK for security and condition.

# (4) RIGHT WING

1. Wing Tie-Down -- DISCONNECT.

4-8 Revision 4

- 2. Main Wheel Tire -- CHECK for proper inflation and general condition (weather checks, tread depth and wear, etc...).
- 3. Fuel Tank Sump Quick Drain Valves -- DRAIN at least a cupful of fuel (using sampler cup) from each sump location to check for water, sediment, and proper fuel grade before each flight and after each refueling. If water is observed, take further samples until clear and then gently rock wings and lower tail to the ground to move any additional contaminants to the sampling points. Take repeated samples from all fuel drain points until all contamination has been removed. If contaminants are still present, refer to WARNING below and do not fly airplane.

# **A** WARNING

IF, AFTER REPEATED SAMPLING, EVIDENCE OF CONTAMINATION STILL EXISTS, THE AIRPLANE SHOULD NOT BE FLOWN. TANKS SHOULD BE DRAINED AND SYSTEM PURGED BY QUALIFIED MAINTENANCE PERSONNEL. ALL EVIDENCE OF CONTAMINATION MUST BE REMOVED BEFORE FURTHER FLIGHT.

- 4. Fuel Quantity -- CHECK VISUALLY for desired level.
- 5. Fuel Filler Cap -- SECURE and VENT UNOBSTRUCTED.

# (5) NOSE

1. Fuel Strainer Quick Drain Valve (Located on bottom of fuselage) -- DRAIN at least a cupful of fuel (using sampler cup) from valve to check for water, sediment, and proper fuel grade before each flight and after each refueling. If water is observed, take further samples until clear and then gently rock wings and lower tail to the ground to move any additional contaminants to the sampling points. Take repeated samples from all fuel drain points, including the fuel reservoir and fuel selector, until all contamination has been removed. If contaminants are still present, refer to WARNING above and do not fly the airplane.

- Engine Oil Dipstick/Filler Cap -- CHECK oil level, then check dipstick/filler cap SECURE. Do not operate with less than five quarts. Fill to eight quarts for extended flight.
- 3. Engine Cooling Air Inlets -- CLEAR of obstructions.
- 4. Propeller and Spinner -- CHECK for nicks and security.
- Air Filter -- CHECK for restrictions by dust or other foreign matter.
- 6. Nose Wheel Strut and Tire -- CHECK for proper inflation of strut and general condition (weather checks, tread depth and wear, etc...) of tire.
- 7. Left Static Source Opening -- CHECK for blockage.

# 6 LEFT WING

- 1. Fuel Quantity -- CHECK VISUALLY for desired level.
- 2. Fuel Filler Cap -- SECURE and VENT UNOBSTRUCTED.
- 3. Fuel Tank Sump Quick Drain Valves -- DRAIN at least a cupful of fuel (using sampler cup) from each sump location to check for water, sediment, and proper fuel grade before each flight and after each refueling. If water is observed, take further samples until clear and then gently rock wings and lower tail to the ground to move any additional contaminants to the sampling points. Take repeated samples from all fuel drain points until all contamination has been removed. If contaminants are still present, refer to WARNING on page 4-9 and do not fly airplane.
- 4. Main Wheel Tire -- CHECK for proper inflation and general condition (weather checks, tread depth and wear, etc...).

4-10 Revision 4

# 7 LEFT WING Leading Edge

- 1. Fuel Tank Vent Opening -- CHECK for blockage.
- Stall Warning Opening -- CHECK for blockage. To check the system, place a clean handkerchief over the vent opening and apply suction; a sound from the warning horn will confirm system operation.
- 3. Wing Tie-Down -- DISCONNECT.
- Landing/Taxi Light(s) -- CHECK for condition and cleanliness of cover.

# 8 LEFT WING Trailing Edge

- 1. Aileron-- CHECK for freedom of movement and security.
- 2. Flap -- CHECK for security and condition.

#### **BEFORE STARTING ENGINE**

- 1. Preflight Inspection -- COMPLETE.
- 2. Passenger Briefing -- COMPLETE.
- 3. Seats and Seat Belts -- ADJUST and LOCK. Ensure inertia reel locking.
- 4. Brakes -- TEST and SET.
- 5. Circuit Breakers -- CHECK IN.
- 6. Electrical Equipment -- OFF.

# **A** CAUTION

THE AVIONICS MASTER SWITCH MUST BE OFF DURING ENGINE START TO PREVENT POSSIBLE DAMAGE TO AVIONICS.

- 7. Avionics Master Switch -- OFF.
- 8. Fuel Selector Valve -- BOTH.
- 9. Fuel Shutoff Valve -- ON (push full in).
- 10. Avionics Circuit Breakers -- CHECK IN.

# **STARTING ENGINE (With Battery)**

- 1. Throttle -- OPEN 1/4 INCH.
- 2. Mixture -- IDLE CUTOFF.
- 3. Propeller Area -- CLEAR.
- 4. Master Switch -- ON.
- 5. Flashing Beacon -- ON.

#### NOTE

If engine is warm, omit priming procedure of steps 6, 7 and 8 below.

- 6. Auxiliary Fuel Pump Switch -- ON.
- 7. Mixture -- SET to FULL RICH (full forward) until stable fuel flow is indicated (usually 3 to 5 seconds), then set to IDLE CUTOFF (full aft) position.
- 8. Auxiliary Fuel Pump Switch -- OFF.
- 9. Ignition Switch -- START (release when engine starts).
- 10. Mixture -- ADVANCE smoothly to RICH when engine starts.

#### NOTE

If engine floods (engine has been primed too much), turn off auxiliary fuel pump, place mixture to idle cutoff, open throttle 1/2 to full, and motor (crank) engine. When engine starts, set mixture to full rich and close throttle promptly.

- 11. Oil Pressure -- CHECK.
- 12. Navigation Lights -- ON as required.
- 13. Avionics Master Switch -- ON.
- 14. Radios -- ON.
- 15. Flaps -- RETRACT.

4-12 Revision 4

# **STARTING ENGINE (With External Power)**

- 1. Throttle -- OPEN 1/4 INCH.
- 2. Mixture -- IDLE CUTOFF.
- 3. Propeller Area -- CLEAR.
- 4. Master Switch -- OFF.
- 5. External Power -- CONNECT to airplane receptacle.
- 6. Master Switch -- ON.
- 7. Flashing Beacon -- ON.

#### NOTE

If engine is warm, omit priming procedure of steps 8, 9 and 10 below.

- 8. Auxiliary Fuel Pump Switch -- ON.
- Mixture -- SET to FULL RICH (full forward) until stable fuel flow is indicated (usually 3 to 5 seconds), then set to IDLE CUTOFF (full aft) position.
- 10. Auxiliary Fuel Pump Switch -- OFF.
- 11. Ignition Switch -- START (release when engine starts).
- 12. Mixture -- ADVANCE smoothly to RICH when engine starts.

#### NOTE

If engine floods (engine has been primed to much), turn off auxiliary fuel pump, set mixture in idle cutoff, open throttle 1/2 to full, and motor (crank) engine. When engine starts, set mixture to full rich and close throttle promptly.

- 13. Oil Pressure -- CHECK.
- 14. External Power -- DISCONNECT from airplane receptacle. Secure external power door.
- 15. Electrical System -- CHECK FOR PROPER OPERATION.
  - Master Switch -- OFF (disconnects both the battery and alternator from the system).

- b. Taxi and Landing Light Switches -- ON. (to provide an initial electrical load on the system).
- Engine RPM -- REDUCE to idle.
   (Minimum alternator output occurs at idle.)
- d. Master Switch -- ON (with taxi and landing lights switched on).
  - (The ammeter should indicate in the negative direction, showing that the alternator output is below the load requirements, but the battery is supplying current to the system.)
- e. Engine RPM -- INCREASE to approximately 1500 RPM (as engine RPM increases, alternator output should increase to meet the system load requirements).
- f. Ammeter and Low Voltage Annunciator -- CHECK (the ammeter should indicate in the positive direction, showing that the alternator is supplying current and the Low Voltage Annunciator (VOLTS) should not be lighted).

#### NOTE

If the indications, as noted in Step "d" and Step "f", are not observed, the electrical system is not functioning properly. Corrective maintenance must be performed to provide for proper electrical system operation before flight.

- 16. Navigation Lights -- ON as required.
- 17. Avionics Master Switch -- ON.
- 18. Radios -- ON.
- 19. Flaps -- RETRACT.

4-14 Revision 4

#### **BEFORE TAKEOFF**

- 1. Parking Brake -- SET.
- 2. Passenger Seat Backs -- MOST UPRIGHT POSITION.
- 3. Seats and Seat Belts -- CHECK SECURE.
- 4. Cabin Doors -- CLOSED and LOCKED.
- 5. Flight Controls -- FREE and CORRECT.
- 6. Flight Instruments -- CHECK and SET.
- 7. Fuel Quantity -- CHECK.
- 8. Mixture -- RICH.
- 9. Fuel Selector Valve -- RECHECK BOTH.
- 10. Throttle -- 1800 RPM.
  - Magnetos -- CHECK (RPM drop should not exceed 150 RPM on either magneto or 50 RPM differential between magnetos).
  - b. Vacuum Gage -- CHECK.
  - c. Engine Instruments and Ammeter -- CHECK.
- 11. Annunciator Panel -- Ensure no annunciators are illuminated.
- 12. Throttle -- CHECK IDLE.
- 13. Throttle -- 1000 RPM or LESS.
- 14. Throttle Friction Lock -- ADJUST.
- 15. Strobe Lights -- AS DESIRED.
- 16. Radios and Avionics -- SET.
- 17. NAV/GPS Switch (if installed) -- SET.
- 18. Autopilot (if installed) -- OFF.
- 19. Manual Electric Trim (if installed) -- CHECK.
- 20. Elevator Trim -- SET for takeoff.
- 21. Wing Flaps -- SET for takeoff (0°-10°).
- 22. Brakes -- RELEASE.

#### **TAKEOFF**

#### **NORMAL TAKEOFF**

- 1. Wing Flaps -- 0°-10°.
- 2. Throttle -- FULL OPEN.
- 3. Mixture -- RICH (above 3000 feet, LEAN to obtain maximum RPM).
- 4. Elevator Control -- LIFT NOSE WHEEL (at 55 KIAS).
- 5. Climb Speed -- 70-80 KIAS.
- 6. Wing Flaps -- RETRACT.

#### SHORT FIELD TAKEOFF

- 1. Wing Flaps -- 10°.
- 2. Brakes -- APPLY.
- 3. Throttle -- FULL OPEN.
- 4. Mixture -- RICH (above 3000 feet, LEAN to obtain maximum RPM).
- Brakes -- RELEASE.
- 6. Elevator Control -- SLIGHTLY TAIL LOW.
- 7. Climb Speed -- 56 KIAS (until all obstacles are cleared).
- 8. Wing Flaps -- RETRACT slowly after reaching 60 KIAS.

#### ENROUTE CLIMB

- 1. Airspeed -- 70-85 KIAS.
- 2. Throttle -- FULL OPEN.
- 3. Mixture -- RICH (above 3000 feet, LEAN to obtain maximum RPM).

# **CRUISE**

- 1. Power -- 2100-2700 RPM (No more than 75% is recommended).
- 2. Elevator Trim -- ADJUST.
- 3. Mixture -- LEAN.

### DESCENT

- 1. Power -- AS DESIRED.
- Mixture -- ADJUST for smooth operation (full rich for idle power).
- 3. Altimeter -- SET.
- 4. NAV/GPS Switch -- SET.
- 5. Fuel Selector Valve -- BOTH.
- 6. Wing Flaps -- AS DESIRED (0° 10° below 110 KIAS, 10° 30° below 85 KIAS).

# **BEFORE LANDING**

- Pilot and Passenger Seat Backs -- MOST UPRIGHT POSITION.
- Seats and Seat Belts -- SECURED and LOCKED.
- 3. Fuel Selector Valve -- BOTH.
- 4. Mixture -- RICH.
- Landing/Taxi Lights -- ON.
- 6. Autopilot (if installed) -- OFF.

4-16 Revision 4

#### LANDING

#### **NORMAL LANDING**

- 1. Airspeed -- 65-75 KIAS (flaps UP).
- 2. Wing Flaps -- AS DESIRED (0°-10° below 110 KIAS, 10°-30° below 85 KIAS).
- 3. Airspeed -- 60-70 KIAS (flaps DOWN).
- 4. Touchdown -- MAIN WHEELS FIRST.
- 5. Landing Roll -- LOWER NOSE WHEEL GENTLY.
- 6. Braking -- MINIMUM REQUIRED.

#### SHORT FIELD LANDING

- 1. Airspeed -- 65-75 KIAS (flaps UP).
- 2. Wing Flaps -- FULL DOWN (30°).
- 3. Airspeed -- 61 KIAS (until flare).
- 4. Power -- REDUCE to idle after clearing obstacle.
- 5. Touchdown -- MAIN WHEELS FIRST.
- 6. Brakes -- APPLY HEAVILY.
- 7. Wing Flaps -- RETRACT.

#### **BALKED LANDING**

- 1. Throttle -- FULL OPEN.
- 2. Wing Flaps -- RETRACT TO 20°.
- 3. Climb Speed -- 60 KIAS.
- Wing Flaps -- 10° (until obstacles are cleared).
   RETRACT (after reaching a safe altitude and 65 KIAS).

# **AFTER LANDING**

1. Wing Flaps -- UP.

### **SECURING AIRPLANE**

- 1. Parking Brake -- SET.
- 2. Electrical Equipment, Autopilot (if installed) -- OFF.
- 3. Avionics Master Switch -- OFF.
- 4. Mixture -- IDLE CUTOFF (pulled full out).
- 5. Ignition Switch -- OFF.
- 6. Master Switch -- OFF.
- 7. Control Lock -- INSTALL.
- Fuel Selector Valve -- LEFT or RIGHT to prevent cross feeding.

#### **AMPLIFIED PROCEDURES**

#### PREFLIGHT INSPECTION

The Preflight Inspection, described in Figure 4-1 and adjacent checklist, is required prior to each flight. If the airplane has been in extended storage, has had recent major maintenance, or has been operated from marginal airports, a more extensive exterior inspection is recommended.

After major maintenance has been performed, the flight and trim tab controls should be double checked for free and correct movement and security. The security of all inspection plates on the airplane should be checked following periodic inspections. If the airplane has been waxed or polished, check the external static pressure source hole for stoppage.

If the airplane has been exposed to much ground handling in a crowded hangar, it should be checked for dents and scratches on wings, fuselage, and tail surfaces, damage to navigation and anticollision lights, damage to nose wheel as a result of exceeding tow limits, and avionics antennas.

Outside storage for long periods may result in dust and dirt accumulation on the induction air filter, obstructions in airspeed system lines. water contaminants in fuel tanks and insect/bird/rodent nests in any opening. If any water is detected in the fuel system, the fuel tank sump quick drain valves, fuel reservoir quick drain valve, and fuel strainer quick drain valve should all be thoroughly drained again. Then, the wings should be gently rocked and the tail lowered to the ground to move any further contaminants to the sampling points. Repeated samples should then be taken at all quick drain points until all contamination has been removed. If, after repeated sampling, evidence of contamination still exists, the fuel tanks should be completely drained and the fuel system cleaned.

Additionally, if the airplane has been stored outside in windy or gusty areas, or tied down adjacent to taxiing airplanes, special attention should be paid to control surface stops, hinges, and brackets to detect the presence of potential wind damage.

4-18 May 30/00

If the airplane has been operated from muddy fields or in snow or slush, check the main and nose gear wheel fairings for obstructions and cleanliness. Operation from a gravel or cinder field will require extra attention to propeller tips and abrasion on leading edges of the horizontal tail. Stone damage to the propeller can seriously reduce the fatigue life of the blades.

Airplanes that are operated from rough fields, especially at high altitudes, are subjected to abnormal landing gear abuse. Frequently check all components of the landing gear, shock strut, tires, and brakes. If the shock strut is insufficiently extended, undue landing and taxi loads will be subjected on the airplane structure.

To prevent loss of fuel in flight, make sure the fuel tank filler caps are tightly sealed after any fuel system check or servicing. Fuel system vents should also be inspected for obstructions, ice or water, especially after exposure to cold, wet weather.

#### STARTING ENGINE

In cooler weather, the engine compartment temperature drops off rapidly following engine shutdown and the injector nozzle lines remain nearly full of fuel.

However, in warmer weather, engine compartment temperatures may increase rapidly following engine shutdown, and fuel in the lines will vaporize and escape into the intake manifold. Hot weather starting procedures depend considerably on how soon the next engine start is attempted. Within the first 20 to 30 minutes after shutdown, the fuel manifold is adequately primed and the empty injector nozzle lines will fill before the engine dies. However, after approximately 30 minutes, the vaporized fuel in the manifold will have nearly dissipated and some slight "priming" could be required to refill the nozzle lines and keep the engine running after the initial start. Starting a hot engine is facilitated by advancing the mixture control promptly to 1/3 open when the engine starts, and then smoothly to full rich as power develops.

Should the engine tend to die after starting, turn on the auxiliary fuel pump temporarily and adjust the throttle and/or mixture as necessary to keep the engine running. In the event of over priming or flooding, turn off the auxiliary fuel pump, open the throttle from 1/2 to full open, and continue cranking with the mixture full lean.

When the engine starts, smoothly advance the mixture control to full rich and retard the throttle to desired idle speed.

If the engine is under primed (most likely in cold weather with a cold engine) it will not start at all, and additional priming will be necessary.

After starting, if the oil pressure gage does not begin to show pressure within 30 seconds in the summer time and approximately one minute in very cold weather, stop the engine and investigate. Lack of oil pressure can cause serious engine damage.

#### NOTE

Additional details concerning cold weather starting and operation may be found under COLD WEATHER OPERATION paragraphs in this section.

#### RECOMMENDED STARTER DUTY CYCLE

Crank the starter for 10 seconds followed by a 20 second cool down period. This cycle can be repeated two additional times, followed by a ten minute cool down period before resuming cranking. After cool down, crank the starter again, three cycles of 10 seconds followed by 20 seconds of cool down. If the engine still fails to start, an investigation to determine the cause should be initiated.

4-20 Revision 4

#### **LEANING FOR GROUND OPERATIONS**

- For all ground operations, after starting the engine and when the engine is running smoothly:
  - a. set the throttle to 1200 RPM.
  - b. lean the mixture for maximum RPM.
  - set the throttle to an RPM appropriate for ground operations (800 to 1000 RPM recommended).

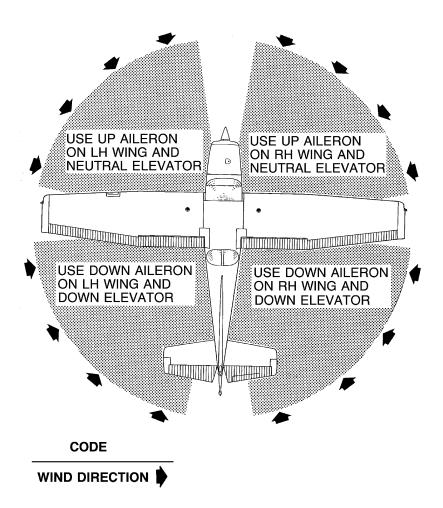
#### NOTE

If ground operation will be required after the BEFORE TAKEOFF checklist is completed, lean the mixture again (as described above) until ready for the TAKEOFF checklist.

#### **TAXIING**

When taxiing, it is important that speed and use of brakes be held to a minimum and that all controls be utilized (Refer to Figure 4-2, Taxiing Diagram) to maintain directional control and balance.

Taxiing over loose gravel or cinders should be done at low engine speed to avoid abrasion and stone damage to the propeller tips.



#### NOTE

Strong quartering tail winds require caution. Avoid sudden bursts of the throttle and sharp braking when the airplane is in this situation. Use the steerable nose wheel and rudder to maintain direction.

0585X1020

Figure 4-2. Taxiing Diagram

# **BEFORE TAKEOFF**

#### **WARM UP**

If the engine idles (approximatley 600 RPM) and accelerates smoothly, the airplane is ready for takeoff. Since the engine is closely cowled for efficient in-flight engine cooling, precautions should be taken to avoid overheating during prolonged engine operation on the ground. Also, long periods of idling may cause fouled spark plugs.

#### MAGNETO CHECK

The magneto check should be made at 1800 RPM as follows. Move ignition switch first to R position and note RPM. Next move switch back to BOTH to clear the other set of plugs. Then move switch to the L position, note RPM and return the switch to the BOTH position. RPM drop should not exceed 150 RPM on either magneto or show greater than 50 RPM differential between magnetos. If there is a doubt concerning operation of the ignition system, RPM checks at higher engine speeds will usually confirm whether a deficiency exists.

An absence of RPM drop may be an indication of faulty grounding of one side of the ignition system or should be cause for suspicion that the magneto timing is set in advance of the setting specified.

#### ALTERNATOR CHECK

Prior to flights where verification of proper alternator and alternator control unit operation is essential (such as night or instrument flights), a positive verification can be made by loading the electrical system momentarily (3 to 5 seconds) with the landing light or by operating the wing flaps during the engine runup (1800 RPM). The ammeter will remain within a needle width of its initial reading if the alternator and alternator control unit are operating properly.

#### LANDING LIGHTS

If landing lights are to be used to enhance the visibility of the airplane in the traffic pattern or enroute, it is recommended that only the taxi light be used. This will extend the service life of the landing light appreciably.

#### **TAKEOFF**

#### **POWER CHECK**

It is important to check full throttle engine operation early in the takeoff roll. Any sign of rough engine operation or sluggish engine acceleration is good cause for discontinuing the takeoff. If this occurs, you are justified in making a thorough full throttle static runup before another takeoff is attempted. The engine should run smoothly and turn approximately 2300 - 2400 RPM with mixture leaned to provide maximum RPM.

Full throttle run ups over loose gravel are especially harmful to propeller tips. When takeoffs must be made over a gravel surface, it is very important that the throttle be advanced slowly. This allows the airplane to start rolling before high RPM is developed, and the gravel will be blown back of the propeller rather than pulled into it. When unavoidable small dents appear in the propeller blades, they should be immediately corrected as described in Section 8 under Propeller Care.

Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full throttle, static runup.

After full throttle is applied, adjust the throttle friction lock clockwise to prevent the throttle from creeping back from a maximum power position. Similar friction lock adjustments should be made as required in other flight conditions to maintain a fixed throttle setting.

4-24 Revision 4

#### WING FLAP SETTINGS

Normal takeoffs are accomplished with wing flaps 0°-10°. Using 10° wing flaps reduces the ground roll and total distance over an obstacle by approximately 10 percent. **Flap deflections greater than 10° are not approved for takeoff**. If 10° wing flaps are used for takeoff, they should be left down until all obstacles are cleared and a safe flap retraction speed of 60 KIAS is reached. On a short field, 10° wing flaps and an obstacle clearance speed of 56 KIAS should be used.

Soft or rough field takeoffs are performed with 10° flaps by lifting the airplane off the ground as soon as practical in a slightly tail low attitude. If no obstacles are ahead, the airplane should be leveled off immediately to accelerate to a higher climb speed. When departing a soft field with an aft C.G. loading, the elevator trim should be adjusted towards the nose down direction to give comfortable control wheel forces during the initial climb.

#### CROSSWIND TAKEOFF

Takeoffs into strong crosswind conditions normally are performed with the minimum flap setting necessary for the field length, to minimize the drift angle immediately after takeoff. With the ailerons partially deflected into the wind, the airplane is accelerated to a speed slightly higher than normal, then pulled off briskly to prevent possible settling back to the runway while drifting. When clear of the ground, make a coordinated turn into the wind to correct for drift.

#### **ENROUTE CLIMB**

Normal enroute climbs are performed with flaps up and **full throttle** and at speeds 5 to 10 knots higher than best rate-of-climb speeds for the best combination of performance, visibility and engine cooling. The mixture should be **full rich** below 3000 feet and may be leaned above 3000 feet for smoother operation or to obtain maximum RPM. For maximum rate of climb, use the best rate-of-climb speeds showing in the Rate of Climb chart in Section 5. If an obstruction dictates the use of a steep climb angle, the best angle-of-climb speed should be used with flaps up and maximum power. Climbs at speeds lower than the best rate-of-climb speed should be of short duration to improve engine cooling.

#### CRUISE

Normal cruise is performed between 45% and 75% power. The engine RPM and corresponding fuel consumption for various altitudes can be determined by using the data in Section 5.

#### NOTE

Cruising should be done at 75% power as much as practicable until a total of 50 hours has accumulated or oil consumption has stabilized. Operation at this higher power will ensure proper seating of the rings and is applicable to new engines, and engines in service following cylinder replacement or top overhaul of one or more cylinders.

The Cruise Performance charts in Section 5 provide the pilot with detailed information concerning the cruise performance of the Model 172S in still air. Power and altitude, as well as winds aloft, have a strong influence on the time and fuel needed to complete any flight.

The Cruise Performance Table, Figure 4-3, illustrates the true airspeed and nautical miles per gallon during cruise for various altitudes and percent powers, and is based on standard conditions and zero wind. This table should be used as a guide, along with the available winds aloft information, to determine the most favorable altitude and power setting for a given trip. The selection of cruise altitude on the basis of the most favorable wind conditions and the use of low power settings are significant factors that should be considered on every trip to reduce fuel consumption.

In addition to power settings, proper leaning techniques also contribute to greater range and are figured into cruise performance tables. To achieve the recommended lean mixture fuel consumption figures shown in Section 5, the mixture should be leaned using the exhaust gas temperature (EGT) indicator as noted.

#### NOTE

At lower power it may be necessary to richen the mixture slightly to obtain smooth operation.

4-26 Revision 4

	75% P	OWER	65% P	OWER	55% P	OWER
ALTITUDE	KTAS	NMPG	KTAS	NMPG	KTAS	NMPG
Sea Level	114	11.2	108	12.0	101	12.8
4000 feet	119	11.7	112	12.4	104	13.2
8000 feet	124	12.2	117	12.9	107	13.6

Figure 4-3. Cruise Performance Table

#### LEANING WITH AN EGT INDICATOR

At or below 75% power in level cruise flight, the exhaust gas temperature (EGT) indicator is used to lean the fuel-air mixture for best performance or economy. The Cruise Performance charts in Section 5 are based on the EGT to adjust the mixture to Recommended Lean per Figure 4-4.

MIXTURE DESCRIPTION	EXHAUST GAS TEMPERATURE
RECOMMENDED LEAN (Pilot's Operating Handbook)	50° Rich of Peak EGT
BEST ECONOMY	Peak EGT

Figure 4-4. EGT Table

Use the mixture control vernier adjustment (rotate the knob CCW to lean the mixture) to **slowly** lean, from full rich or maximum RPM mixture, while monitoring the EGT indicator. As the EGT indication begins to increase, continue to **slowly** lean the mixture until an EGT indication decrease is just detectable. Reverse the adjustment **slowly** in the rich direction until an EGT indication decrease is again just detectable, then set the EGT index pointer to match the peak indication. The mixture may be leaned slightly to return to peak EGT or may be further richened to Recommended Lean mixture as desired. **Continuous operation at mixture settings lean of peak EGT is prohibited.** Any change in altitude or throttle position will require that peak EGT be redetermined and the desired mixture be reset. Under some conditions, engine roughness may occur at peak EGT. In this case, operate at Recommended Lean mixture.

As noted in Figure 4-4, operation at peak EGT provides the best fuel economy. Operation at peak EGT results in approximately 4% greater range and approximately a 3 knot decrease in airspeed from the figures shown in the Performance section of this handbook. Recommended Lean mixture provides best level cruise performance (generally close to "best power" or maximum RPM).

#### NOTE

The EGT indicator requires several seconds to respond to mixture adjustments and changes in exhaust gas temperature. More rapid changes in EGT indication are neither necessary nor desirable. Determining peak EGT and setting the desired mixture should take approximately one minute when the adjustments are made sufficiently slowly and accurately.

# FUEL SAVINGS PROCEDURES FOR FLIGHT TRAINING OPERATIONS

For best fuel economy during flight training operations, the following procedures are recommended.

- After engine start and for all ground operations, set the throttle to 1200 RPM and lean the mixture for maximum RPM. Leave the mixture at this setting until beginning the BEFORE TAKEOFF checklist. After the BEFORE TAKEOFF checklist is complete re-lean the mixture as described above until ready for the TAKEOFF checklist.
- Lean the mixture for maximum RPM during full throttle climbs above 3000 feet. The mixture may remain leaned (maximum RPM at full throttle) for practicing maneuvers such as stalls and slow flight.
- 3. Lean the mixture for maximum RPM during all operations at any altitude, including those below 3000 feet, when using 75% or less power.

#### **NOTE**

- When cruising or maneuvering at 80% or less power, the mixture may be further leaned until the EGT indicator needle peaks and is then enrichened 50°F. This is especially applicable to cross-country training flights, but should be practiced during transition flight to and from the practice area as well.
- Using the above recommended procedures can provide fuel savings in excess of 5% when compared to typical training operations at full rich mixture. In addition, the above procedures will minimize spark plug fouling since the reduction in fuel consumption results in a proportional reduction in tetraethyl lead passing through the engine.

4-28 Revision 4

#### **FUEL VAPOR PROCEDURES**

The engine fuel system can become susceptible to fuel vapor formation on the ground during warm weather. This will generally occur when the outside ambient air temperature is above 80°F. The situation is further aggravated by the fact that the engine fuel flows are lower at idle and taxi engine speeds. When vapor occurs as evidenced by idle engine speed and fuel flow fluctuations, the following procedures are recommended.

- 1. With the mixture full rich, set the throttle at 1800 RPM to 2000 RPM. Maintain this power setting for 1 to 2 minutes or until smooth engine operation returns.
- 2. Retard the throttle to idle to verify normal engine operation.
- Advance the throttle to 1200 RPM and lean the mixture as described under FUEL SAVINGS PROCEDURES FOR FLIGHT TRAINING OPERATIONS.
- 4. Just prior to TAKEOFF, apply full throttle, for approximately 10 seconds to verify smooth engine operation for takeoff.

#### NOTE

When the engine is operated above 1800 RPM, the resulting increased fuel flow also makes for lower fuel temperatures throughout the engine fuel system. This increased flow purges the fuel vapor and the cooler fuel minimizes vapor formation.

In addition to the above procedures, the sections below should be reviewed and where applicable, adhered to:

- Section 2 -- Take note of the placard on "When Switching From Dry Tank".
- Section 3 -- Take note of the excessive fuel vapor procedures in both the checklist and the amplified procedures sections.
- Section 4 -- Take note of the hot weather operational notes and procedures in both the checklist and the amplified procedures sections.
- Section 7 -- Take note of the altitude operational procedures and the section on auxiliary fuel pump operation.

#### **STALLS**

The stall characteristics are conventional and aural warning is provided by a stall warning horn which sounds between 5 and 10 knots above the stall in all configurations.

Power off stall speeds at maximum weight for both forward and aft C.G. positions are presented in Section 5.

#### **SPINS**

Intentional spins are approved when the airplane is operated in the utility category. Spins with baggage loadings or occupied rear seat(s) are not approved.

However, before attempting to perform spins several items should be carefully considered to assure a safe flight. No spins should be attempted without first having received dual instruction both in spin entries and spin recoveries from a qualified instructor who is familiar with the spin characteristics of the Cessna 172S.

The cabin should be clean and all loose equipment (including the microphone and rear seat belts) should be stowed or secured. For a solo flight in which spins will be conducted, the copilot's seat belt and shoulder harness should also be secured. Care should be taken to ensure that the pilot can easily reach the flight controls and produce maximum control travels.

It is recommended that, where feasible, entries be accomplished at high enough altitude that recoveries are completed 4000 feet or more above ground level. At least 1000 feet of altitude loss should be allowed for a 1-turn spin and recovery, while a 6-turn spin and recovery may require somewhat more than twice that amount. For example, the recommended entry altitude for a 6-turn spin would be 6000 feet above ground level. In any case, entries should be planned so that recoveries are completed well above the minimum 1500 feet above ground level required by FAR 91.303. Another reason for using high altitudes for practicing spins is that a greater field of view is provided which will assist in maintaining pilot orientation.

4-30 Revision 4

The normal entry is made from a power off stall. As the stall is approached, the elevator control should be smoothly pulled to the full aft position. Just prior to reaching the stall "break", rudder control in the desired direction of the spin rotation should be applied so that full rudder deflection is reached almost simultaneously with reaching full aft elevator. A slightly greater rate of deceleration than for normal stall entries, application of ailerons in the direction of the desired spin, and the use of power at the entry will assure more consistent and positive entries to the spin. As the airplane begins to spin, reduce the power to idle and return the ailerons to neutral. Both elevator and rudder controls should be held full with the spin until the spin recovery is initiated. An inadvertent relaxation of either of these controls could result in the development of a nose down spiral.

For the purpose of training in spins and spin recoveries, a 1 or 2 turn spin is adequate and should be used. Up to 2 turns, the spin will progress to a fairly rapid rate of rotation and a steep attitude. Application of recovery controls will produce prompt recoveries (within 1/4 turn). During extended spins of two to three turns or more, the spin will tend to change into a spiral, particularly to the right. This will be accompanied by an increase in airspeed and gravity loads on the airplane. If this occurs, recovery should be accomplished promptly but smoothly by leveling the wings and recovering from the resulting dive.

Regardless of how many turns the spin is held or how it is entered, the following recovery technique should be used:

- VERIFY THAT THROTTLE IS IN IDLE POSITION AND AILERONS ARE NEUTRAL.
- 2. APPLY AND **HOLD** FULL RUDDER OPPOSITE TO THE DIRECTION OF ROTATION.
- 3. JUST **AFTER** THE RUDDER REACHES THE STOP, MOVE THE CONTROL WHEEL **BRISKLY** FORWARD FAR ENOUGH TO BREAK THE STALL.
- 4. **HOLD** THESE CONTROL INPUTS UNTIL ROTATION STOPS.
- 5. AS ROTATION STOPS, NEUTRALIZE RUDDER, AND MAKE A SMOOTH RECOVERY FROM THE RESULTING DIVE.

#### NOTE

If disorientation precludes a visual determination of the direction of rotation, the symbolic airplane in the turn coordinator may be referred to for this information.

Variations in basic airplane rigging or in weight and balance due to installed equipment or right seat occupancy can cause differences in behavior, particularly in extended spins. These differences are normal and will result in variations in the spin characteristics and in the spiraling tendencies for spins of more than 2 turns. However, the recovery technique should always be used and will result in the most expeditious recovery from any spin.

Intentional spins with flaps extended are prohibited, since the high speeds which may occur during recovery are potentially damaging to the flap/wing structure.

#### LANDING

#### **NORMAL LANDING**

Normal landing approaches can be made with power on or power off with any flap setting desired. Surface winds and air turbulence are usually the primary factors in determining the most comfortable approach speeds. Steep slips should be avoided with flap settings greater than 20° due to a slight tendency for the elevator to oscillate under certain combinations of airspeed, sideslip angle, and center of gravity loadings.

Actual touchdown should be made with power off and on the main wheels first to reduce the landing speed and subsequent need for braking in the landing roll. The nose wheel is lowered to the runway gently after the speed has diminished to avoid unnecessary nose gear loads. This procedure is especially important in rough or soft field landings.

4-32 Revision 4

#### SHORT FIELD LANDING

For a short field landing in smooth air conditions, make an approach at 61 KIAS with 30° flaps using enough power to control the glide path. (Slightly higher approach speeds should be used under turbulent air conditions.) After all approach obstacles are cleared, progressively reduce power and maintain the approach speed by lowering the nose of the airplane. Touchdown should be made with power off and on the main wheels first. Immediately after touchdown, lower the nose wheel and apply heavy braking as required. For maximum brake effectiveness, retract the flaps, hold the control wheel full back, and apply maximum brake pressure without sliding the tires.

#### **CROSSWIND LANDING**

When landing in a strong crosswind, use the minimum flap setting required for the field length. If flap settings greater than 20° are used in sideslips with full rudder deflection, some elevator oscillation may be felt at normal approach speeds. However, this does not affect control of the airplane. Although the crab or combination method of drift correction may be used, the wing low method gives the best control. After touchdown, hold a straight course with the steerable nose wheel and occasional braking if necessary.

The maximum allowable crosswind velocity is dependent upon pilot capability as well as airplane limitations. Operation in direct crosswinds of 15 knots has been demonstrated.

#### **BALKED LANDING**

In a balked landing (go-around) climb, reduce the flap setting to 20° immediately after full power is applied. If obstacles must be cleared during the go-around climb, reduce the wing flap setting to 10° and maintain a safe airspeed until the obstacles are cleared. Above 3000 feet, lean the mixture to obtain maximum RPM. After clearing any obstacles, the flaps may be retracted as the airplane accelerates to the normal flaps up climb speed.

Revision 4 4-33

#### **COLD WEATHER OPERATION**

Special consideration should be given to the operation of the airplane fuel system during the winter season or prior to any flight in cold temperatures. Proper preflight draining of the fuel system is especially important and will eliminate any free water accumulation. The use of additives such as isopropyl alcohol or diethylene glycol monomethyl ether may also be desirable. Refer to Section 8 for information on the proper use of additives.

Cold weather often causes conditions which require special care during airplane operations. Even small accumulations of frost, ice, or snow must be removed, particularly from wing, tail and all control surfaces to assure satisfactory flight performance and handling. Also, control surfaces must be free of any internal accumulations of ice or snow.

If snow or slush covers the takeoff surface, allowance must be made for takeoff distances which will be increasingly extended as the snow or slush depth increases. The depth and consistency of this cover can, in fact, prevent takeoff in many instances.

#### **WARNING**

WHEN PULLING THE PROPELLER THROUGH BY HAND, TREAT IT AS IF THE IGNITION SWITCH IS TURNED ON. A LOOSE OR BROKEN GROUND WIRE ON EITHER MAGNETO COULD CAUSE THE ENGINE TO FIRE.

Prior to starting on cold mornings, it is advisable to pull the propeller through several times by hand to "break loose" or "limber" the oil, thus conserving battery energy.

When air temperatures are below 20°F (-6°C), the use of an external preheater and an external power source are recommended whenever possible to obtain positive starting and to reduce wear and abuse to the engine and electrical system. Preheat will thaw the oil trapped in the oil cooler, which probably will be congealed prior to starting in extremely cold temperatures.

4-34 Revision 4

When using an external power source, the master switch must be in the OFF position before connecting the external power source to the airplane receptacle. See Section 7, Ground Service Plug Receptacle for external power source operations.

Cold weather starting procedures are the same as the normal starting procedures. Use caution to prevent inadvertent forward movement of the airplane during starting when parked on snow or ice.

#### NOTE

If the engine does not start during the first few attempts, or if engine firing diminishes in strength, it is probable that the spark plugs have been frosted over. Preheat must be used before another start is attempted.

During cold weather operations, no indication will be apparent on the oil temperature gage prior to takeoff if outside air temperatures are very cold. After a suitable warm up period (2 to 5 minutes at 1000 RPM), accelerate the engine several times to higher engine RPM. If the engine accelerates smoothly and the oil pressure remains normal and steady, the airplane is ready for takeoff.

#### WINTERIZATION KIT

A winterization kit is provided and may be utilized when cold weather operations are conducted.

Revision 4 4-35

#### HOT WEATHER OPERATION

Refer to the general warm temperature starting information under Starting Engine in this section. Avoid prolonged engine operation on the ground.

### NOISE CHARACTERISTICS AND NOISE REDUCTION

The certificated noise level for the Model 172S at 2550 pounds maximum weight is 75.1 dB(A). No determination has been made by the Federal Aviation Administration that the noise levels of this airplane are or should be acceptable or unacceptable for operation at, into, or out of, any airport.

The following procedures are suggested to minimize the effect of airplane noise on the public:

- Pilots operating airplanes under VFR over outdoor assemblies
  of persons, recreational and park areas, and other noise
  sensitive areas should make every effort to fly not less than
  2000 feet above the surface, weather permitting, even though
  flight at a lower level may be consistent with the provisions of
  government regulations.
- During departure from or approach to an airport, climb after takeoff and descent for landing should be made so as to avoid prolonged flight at low altitude near noise sensitive areas.

#### NOTE

The above recommended procedures do not apply where they would conflict with Air Traffic Control clearances or instructions, or where, in the pilot's judgment, an altitude of less than 2000 feet is necessary to adequately exercise the duty to see and avoid other airplanes.

4-36 Revision 4

# SECTION 5 PERFORMANCE

TABLE OF CONTENTS	Page
Introduction	5-3
Use of Performance Charts	5-3
Sample Problem	5-3
Takeoff	5-4
Cruise	5-5
Fuel Required	5-6
Landing	5-8
Demonstrated Operating Temperature	5-8
Figure 5-1, Airspeed Calibration - Normal Static Source	. 5-9
Airspeed Calibration - Alternate Static Source	5-10
Figure 5-2, Temperature Conversion Chart	5-11
Figure 5-3, Stall Speeds	5-12
Figure 5-4, Crosswind Components	5-13
Figure 5-5, Short Field Takeoff Distance	5-14
Figure 5-6, Maximum Rate Of Climb	5-17
Figure 5-7, Time, Fuel, And Distance To Climb	5-18
Figure 5-8, Cruise Performance	5-19
Figure 5-9, Range Profile	5-21
Figure 5-10, Endurance Profile	5-22
Figure 5-11 Short Field Landing Distance	5-23

#### 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 approximating average piloting techniques.

It should be noted that 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 at all altitudes. 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 and to flight plan in a conservative manner.

#### **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. Assume the following information has already been determined:

AIRPLANE CONFIGURATION:

Takeoff weight 2550 Pounds Usable fuel 53 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

CRUISE CONDITIONS:

Total distance 360 Nautical Miles

Pressure altitude 7500 Feet

Temperature 16°C (16°C Above Standard)

Expected wind enroute 10 Knot Headwind

LANDING CONDITIONS:

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

#### **TAKEOFF**

The takeoff distance chart, Figure 5-5, should be consulted, keeping in mind that 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 2550 pounds, pressure altitude of 2000 feet and a temperature of 30°C should be used and results in the following:

Ground roll 1285 Feet
Total distance to clear a 50-foot obstacle 2190 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:

12 Knots X 10% = 13% Decrease 9 Knots

This results in the following distances, corrected for wind:

Ground roll, zero wind 1285
Decrease in ground roll -167

(1285 feet X 13%)

Corrected ground roll 1118 Feet

Total distance to clear a
50-foot obstacle, zero wind
2190
Decrease in total distance

(2190 feet X 13%) - <u>285</u>

Corrected total distance

to clear 50-foot obstacle 1905 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 5-8, the range profile chart presented in Figure 5-9, and the endurance profile chart presented in Figure 5-10.

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 5-8, is entered at 8000 feet pressure 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 2600 RPM, which results in the following:

Power 64%
True airspeed 117 Knots
Cruise fuel flow 8.9 GPH

Revision 4 5-5

#### **FUEL REQUIRED**

The total fuel requirement for the flight may be estimated using the performance information in Figure 5-7 and Figure 5-8. For this sample problem, Figure 5-7 shows that a climb from 2000 feet to 8000 feet requires 2.2 gallons of fuel. The corresponding distance during the climb is 15 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 (16°C - 0°C), the correction would be:

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

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

Fuel to climb, standard temperature	2.2
Increase due to non-standard temperature	0.4
(2.2 X 16%)	

Corrected fuel to climb 2.6 Gallons

Using a similar procedure for the distance to climb results in 18 nautical miles. (15 nm using chart + 2.4 nm to correct for higher than standard temperature = 17.4 nm. Rounded up to 18 nm.)

5-6 Revision 4

The resultant cruise distance is:

Total distance	360
Climb distance	-18
Cruise distance	3 <u>42</u> nm

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

117 <u>-10</u>

107 Knots

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

$$\frac{342}{107}$$
 Nautical Miles = 3.2 Hours

The fuel required for cruise is:

3.2 hours X 8.9 gallons/hour = 28.5 Gallons

A 45-minute reserve requires:

$$\frac{45}{60}$$
 X 8.9 gallons / hour = 6.7 Gallons

The total estimated fuel required is as follows:

Engine start, taxi, and takeoff	1.4
Climb	2.6
Cruise	28.5
Reserve	<u>6.7</u>

Total fuel required 39.2 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 5-11 presents landing distance information for the short field technique. The distances corresponding to 2000 feet and 30°C are as follows:

Ground roll 650 Feet Total distance to clear a 50-foot obstacle 1455 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.

5-8 July 8/98

#### **AIRSPEED CALIBRATION**

#### NORMAL STATIC SOURCE

#### CONDITION:

Power required for level flight or maximum power descent.

FLAPS UP												
KIAS	50	60	70	80	90	100	110	120	130	140	150	160
KCAS	56	62	70	78	87	97	107	117	127	137	147	157
FLAPS 10°												
KIAS	40	50	60	70	80	90	100	110				
KCAS	51	57	63	71	80	89	99	109				
FLAPS 30°												
KIAS	40	50	60	70	80	85						
KCAS	50	56	63	72	81	86						

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

#### **AIRSPEED CALIBRATION**

#### ALTERNATE STATIC SOURCE

#### CONDITION:

Power required for level flight or maximum power descent.

FLAPS UP												
KIAS	50	60	70	80	90	100	110	120	130	140	150	160
KCAS	56	62	68	76	85	95	105	115	125	134	144	154
FLAPS 10°												
KIAS	40	50	60	70	80	90	100	110				
KCAS	51	55	60	68	77	86	96	105				
FLAPS 30°												
KIAS	40	50	60	70	80	85						
KCAS	49	54	61	69	78	83						

#### NOTE:

Windows closed, ventilators closed, cabin heater, cabin air, and defroster on maximum.

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

5-10 July 8/98

#### TEMPERATURE CONVERSION CHART

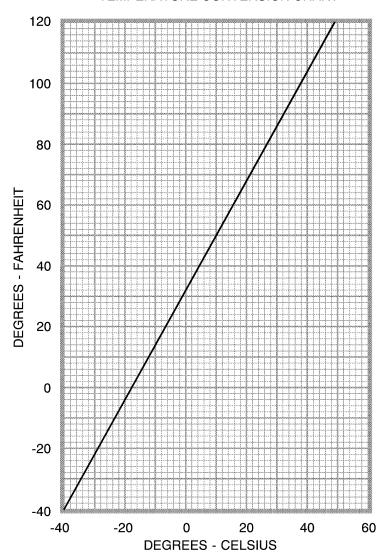


Figure 5-2. Temperature Conversion Chart

#### **STALL SPEEDS AT 2550 POUNDS**

Conditions: Power Off

#### MOST REARWARD CENTER OF GRAVITY

FLAP SETTING		ANGLE OF BANK											
	0	0	30	)°	45	5°	60°						
		KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS					
UP 10° 30°	48 42 40	53 50 48	52 45 43	57 54 52	57 50 48	63 59 57	68 59 57	75 71 68					

#### MOST FORWARD CENTER OF GRAVITY

FLAP SETTING		ANGLE OF BANK											
	C	)°	3	0°	4	5°	60°						
	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS					
UP	48	53	52	57	57	63	68	75					
10°	43	51	46	55	51	61	61	72					
30°	40	48	43	52	48	57	57	68					

#### NOTES:

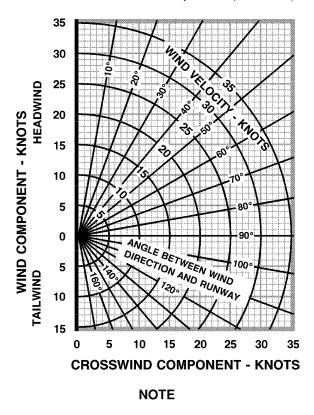
- Altitude loss during a stall recovery may be as much as 230 feet.
   KIAS values are approximate.

Figure 5-3. Stall Speeds

5-12 July 8/98

#### WIND COMPONENTS

NOTE: Maximum demonstrated crosswind velocity is 15 knots (not a limitation).



Maximum demonstrated crosswind component is 15 knots (not a limitation).

0585C1003

Figure 5-4. Crosswind Components

Revision 4 5-13

#### SHORT FIELD TAKEOFF DISTANCE AT 2550 POUNDS

#### CONDITIONS:

Flaps 10°

Full Throttle Prior to Brake Release Paved, level, dry runway

Zero Wind

Lift Off: 51 KIAS Speed at 50 Ft: 56 KIAS

	(	0°C		10°C		)°C	30	)°C	40°C	
Press Alt In Feet	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst								
S. L.	860	1465	925	1575	995	1690	1070	1810	1150	1945
1000	940	1600	1010	1720	1090	1850	1170	1990	1260	2135
2000	1025	1755	1110	1890	1195	2035	1285	2190	1380	2355
3000	1125	1925	1215	2080	1310	2240	1410	2420	1515	2605
4000	1235	2120	1335	2295	1440	2480	1550	2685	1660	2880
5000	1355	2345	1465	2545	1585	2755	1705	2975	1825	3205
6000	1495	2605	1615	2830	1745	3075	1875	3320	2010	3585
7000	1645	2910	1785	3170	1920	3440	2065	3730	2215	4045
8000	1820	3265	1970	3575	2120	3880	2280	4225	2450	4615

#### NOTES:

- 1. Short field technique as specified in Section 4.
- 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 tail winds up to 10 knots, increase distances by 10% for each 2 knots.
- 4. For operation on dry, grass runway, increase distances by 15% of the "ground roll" figure.

Figure 5-5. Short Field Takeoff Distance (Sheet 1 of 3)

5-14 July 8/98

#### SHORT FIELD TAKEOFF DISTANCE **AT 2400 POUNDS**

#### CONDITIONS:

Flaps 10° Full Throttle Prior to Brake Release Paved, level, dry runway Zero Wind

Lift Off: 48 KIAS

Speed at 50 Ft: 54 KIAS

	0°C		10°C		20	)°C	30	)°C	40°C	
Press Alt In Feet	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst								
S. L.	745	1275	800	1370	860	1470	925	1570	995	1685
1000	810	1390	875	1495	940	1605	1010	1720	1085	1845
2000	885	1520	955	1635	1030	1760	1110	1890	1190	2030
3000	970	1665	1050	1795	1130	1930	1215	2080	1305	2230
4000	1065	1830	1150	1975	1240	2130	1335	2295	1430	2455
5000	1170	2015	1265	2180	1360	2355	1465	2530	1570	2715
6000	1285	2230	1390	2410	1500	2610	1610	2805	1725	3015
7000	1415	2470	1530	2685	1650	2900	1770	3125	1900	3370
8000	1560	2755	1690	3000	1815	3240	1950	3500	2095	3790

#### 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 tail winds up to 10 knots, increase distances by 10% for each 2 knots.
- 4. For operation on dry, grass runway, increase distances by 15% of the "ground roll" figure.

Figure 5-5. Short Field Takeoff Distance (Sheet 2 of 3)

5-15 July 8/98

#### SHORT FIELD TAKEOFF DISTANCE **AT 2200 POUNDS**

#### CONDITIONS:

Flaps 10°

Full Throttle Prior to Brake Release

Paved, level, dry runway

Zero Wind

44 KIAS

Lift Off: Speed at 50 Ft: 50 KIAS

	(	0°C	10	)°C	20	)°C	3(	)°C	40°C	
Press Alt In Feet	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst								
S. L.	610	1055	655	1130	705	1205	760	1290	815	1380
1000	665	1145	720	1230	770	1315	830	1410	890	1505
2000	725	1250	785	1340	845	1435	905	1540	975	1650
3000	795	1365	860	1465	925	1570	995	1685	1065	1805
4000	870	1490	940	1605	1010	1725	1090	1855	1165	1975
5000	955	1635	1030	1765	1110	1900	1195	2035	1275	2175
6000	1050	1800	1130	1940	1220	2090	1310	2240	1400	2395
7000	1150	1985	1245	2145	1340	2305	1435	2475	1540	2650
8000	1270	2195	1370	2375	1475	2555	1580	2745	1695	2950

#### 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 tail winds up to 10 knots, increase distances by 10% for each 2 knots.
- 4. For operation on dry, grass runway, increase distances by 15% of the "ground roll" figure.

Figure 5-5. Short Field Takeoff Distance (Sheet 3 of 3)

#### **MAXIMUM RATE-OF-CLIMB AT 2550 POUNDS**

CONDITIONS:

Flaps Up Full Throttle

PRESS ALT	CLIMB SPEED	RATE OF CLIMB - FPM							
FT	KIAS	-20°C	0°C	20°C	40°C				
S.L.	74	855	785	710	645				
2000	73	760	695	625	560				
4000	73	685	620	555	495				
6000	73	575	515	450	390				
8000	72	465	405	345	285				
10,000	72	360	300	240	180				
12,000	72	255	195	135					

#### NOTE:

1. Mixture leaned above 3,000 feet for maximum RPM.

Figure 5-6. Maximum Rate of Climb

#### TIME, FUEL AND DISTANCE TO CLIMB AT 2550 POUNDS

CONDITIONS:

Flaps Up Full Throttle Standard Temperature

PRESS	CLIMAD	RATE	FRC	FROM SEA LEVEL					
ALT FT	CLIMB SPEED KIAS	OF CLIMB FPM	TIME IN MIN	FUEL USED GAL	DIST NM				
S.L.	74	730	0	0.0	0				
1000	73	695	1	0.4	2				
2000	73	655	3	0.8	4				
3000	73	620	4	1.2	6				
4000	73	600	6	1.5	8				
5000	73	550	8	1.9	10				
6000	73	505	10	2.2	13				
7000	73	455	12	2.6	16				
8000	72	410	14	3.0	19				
9000	72	360	17	3.4	22				
10,000	72	315	20	3.9	27				
11,000	72	265	24	4.4	32				
12,000	72	220	28	5.0	38				

#### NOTES:

- 1. Add 1.4 gallons of fuel for engine start, taxi and takeoff allowance.
- 2. Mixture leaned above 3,000 feet for maximum RPM.
- Increase time, fuel and distance by 10% for each 10°C above standard temperature.
- 4. Distances shown are based on zero wind.

Figure 5-7. Time, Fuel and Distance to Climb

5-18 July 8/98

#### **CRUISE PERFORMANCE**

CONDITIONS: 2550 Pounds

Recommended Lean Mixture At All Altitudes (Refer to Section 4, Cruise)

PRESS ALT	RPM		C BELC			STANDARD TEMPERATURE			20°C ABOVE STANDARD TEMP		
FT RPIVI	% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH		
2000	2550	83	117	11.1	77	118	10.5	72	117	9.9	
	2500	78	115	10.6	73	115	9.9	68	115	9.4	
	2400	69	111	9.6	64	110	9.0	60	109	8.5	
	2300	61	105	8.6	57	104	8.1	53	102	7.7	
	2200	53	99	7.7	50	97	7.3	47	95	6.9	
	2100	47	92	6.9	44	90	6.6	42	89	6.3	
4000	2600	83	120	11.1	77	120	10.4	72	119	9.8	
	2550	79	118	10.6	73	117	9.9	68	117	9.4	
	2500	74	115	10.1	69	115	9.5	64	114	8.9	
	2400	65	110	9.1	61	109	8.5	57	107	8.1	
	2300	58	104	8.2	54	102	7.7	51	101	7.3	
	2200	51	98	7.4	48	96	7.0	45	94	6.7	
	2100	45	91	6.6	42	89	6.4	40	87	6.1	
6000	2650	83	122	11.1	77	122	10.4	72	121	9.8	
	2600	78	120	10.6	73	119	9.9	68	118	9.4	
	2500	70	115	9.6	65	114	9.0	60	112	8.5	
	2400	62	109	8.6	57	108	8.2	54	106	7.7	
	2300	54	103	7.8	51	101	7.4	48	99	7.0	
	2200	48	96	7.1	45	94	6.7	43	92	6.4	

Figure 5-8. Cruise Performance (Sheet 1 of 2)

#### **CRUISE PERFORMANCE**

CONDITIONS: 2550 Pounds

Recommended Lean Mixture At All Altitudes (Refer to Section 4, Cruise)

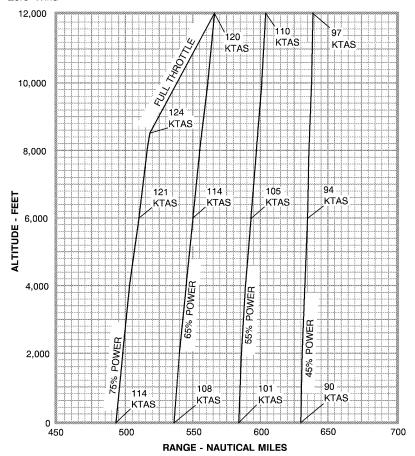
PRESS	DDM		20°C BELOW STANDARD TEMP			STANDARD TEMPERATURE			20°C ABOVE STANDARD TEMP		
ALT FT	RPM	% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH	
8000	2700	83	125	11.1	77	124	10.4	71	123	9.7	
	2650	78	122	10.5	72	122	9.9	67	120	9.3	
	2600	74	120	10.0	68	119	9.4	64	117	8.9	
	2500	65	114	9.1	61	112	8.6	57	111	8.1	
	2400	58	108	8.2	54	106	7.8	51	104	7.4	
	2300	52	101	7.5	48	99	7.1	46	97	6.8	
	2200	46	94	6.8	43	92	6.5	41	90	6.2	
10,000	2700	78	124	10.5	72	123	9.8	67	122	9.3	
	2650	73	122	10.0	68	120	9.4	63	119	8.9	
	2600	69	119	9.5	64	117	9.0	60	115	8.5	
	2500	62	113	8.7	57	111	8.2	54	109	7.8	
	2400	55	106	7.9	51	104	7.5	49	102	7.1	
	2300	49	100	7.2	46	97	6.8	44	95	6.5	
12,000	2650	69	121	9.5	64	119	8.9	60	117	8.5	
	2600	65	118	9.1	61	116	8.5	57	114	8.1	
	2500	58	111	8.3	54	109	7.8	51	107	7.4	
	2400	52	105	7.5	49	102	7.1	46	100	6.8	
	2300	47	98	6.9	44	95	6.6	41	92	6.3	

Figure 5-8. Cruise Performance (Sheet 2 of 2)

5-20 July 8/98

#### RANGE PROFILE 45 MINUTES RESERVE 53 GALLONS USABLE FUEL

CONDITIONS: 2550 Pounds Recommended Lean Mixture for Cruise At All Altitudes Standard Temperature Zero Wind



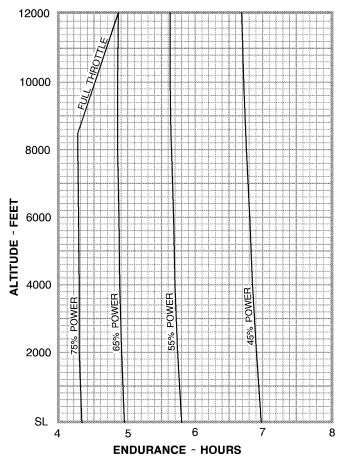
#### NOTES:

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

Figure 5-9. Range Profile

## ENDURANCE PROFILE 45 MINUTES RESERVE 53 GALLONS USABLE FUEL

CONDITIONS: 2550 Pounds Recommended Lean Mixture for Cruise At All Altitudes Standard Temperature



NOTE:

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

Figure 5-10. Endurance Profile

#### SHORT FIELD LANDING DISTANCE AT 2550 POUNDS

#### CONDITIONS:

Flaps 30° Power Off Maximum Braking Paved, level, dry runway Zero Wind Speed at 50 Ft: 61 KIAS

	0°C		0°C 10°C		20	20°C		30°C		40°C	
Press Alt In Feet	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst		Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	
S. L.	545	1290	565	1320	585	1350	605	1380	625	1415	
1000	565	1320	585	1350	605	1385	625	1420	650	1450	
2000	585	1355	610	1385	630	1420	650	1455	670	1490	
3000	610	1385	630	1425	655	1460	675	1495	695	1530	
4000	630	1425	655	1460	675	1495	700	1535	725	1570	
5000	655	1460	680	1500	705	1535	725	1575	750	1615	
6000	680	1500	705	1540	730	1580	755	1620	780	1660	
7000	705	1545	730	1585	760	1625	785	1665	810	1705	
8000	735	1585	760	1630	790	1670	815	1715	840	1755	

#### NOTES:

- 1. Short field technique as specified in Section 4.
- Decrease distances 10% for each 9 knots headwind. For operation with tail winds up to 10 knots, increase distances by 10% for each 2 knots.
- For operation on dry, grass runway, increase distances by 45% of the "ground roll" figure.
- 4. If landing with flaps up, increase the approach speed by 9 KIAS and allow for 35% longer distances.

Figure 5-11. Short Field Landing Distance

Revision 4 5-23/5-24