TRAINING MANUAL

MOONEY PILOT PROFICIENCY PROGRAM

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MOONEY AIRCRAFT PILOT ASSOCIATION
SAFETY FOUNDATION

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Dedication

This Manual is dedicated to all Mooney aircraft pilots
in the belief that more knowledge of their airplane
will surely lead to safer, more enjoyable flying.

The performance data recited in this manual is for illustrative instructional purposes and is not intended to modify or supersede the performance data, procedures and information contained in the appropriate owner's manual. The pilot in command has the responsibility to read and familiarize himself or herself with the appropriate manufacturer's owner's manual and to operate the airplane in accordance with the performance data, procedures and information recited therein.

The pilot in command must also become familiar with all available information concerning each flight, the airworthiness and legality of the airplane, and the pilot's competency, currency and authority for the flight.

Remember, the pilot in command is solely responsible for making all decisions concerning the flights and in each instance has the responsibility for the safe operation of the aircraft.

Mooney Aircraft Pilots Association Safety Foundation
Mooney Pilot Proficiency Program

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Mooney
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INTRODUCTION

Purpose

For an aircraft to perform safely throughout its design envelope it must be properly maintained and flown by a conscientious and proficient pilot who understands the impacts of total weight and atmospheric conditions on the intended mission. The **MAPA Safety Foundation** (MAPASF) has structured this Pilot Proficiency Program to address all of the above factors as they apply specifically to the M20 aircraft series.

This manual is intended to provide those who attend the Mooney Pilot Proficiency Program with a set of notes, which can become a part of the student's aviation library. Materials and subjects discussed during the ground school sessions are included together with selected additional references.

The MAPA Safety Foundation gratefully acknowledges the generous assistance, information and publications provided by the Mooney Aircraft Corporation.

Objectives

Objectives of the MAPA Safety Foundation Pilot Proficiency Program are:

A. To enhance Mooney pilots' safety, enjoyment, and effective use of their aircraft.

B. To present an organized approach to the flight planning areas of Weight and Balance and Aircraft Performance.

C. To improve proficiency and assist in completing flight reviews through type-specific flight instruction.

D. To provide information on Mooney aircraft systems, ADs, SBs, SIs, and inspection/maintenance procedures.

M20 Series History and Overview

Production of the M20 (Al Mooney's twentieth design) series began with the granting of the M20 Type Certificate (TC) on August 24, 1955. A 165 hp Lycoming engine was standard until 1958 when the M20A (TC: Feb. 13, 1958) became the first of a long line to use 180 hp Lycoming.

The wood-winged airplane was metallized to create the M20B (TC: Dec. 14, 1960). The M20C came a year later (TC: Oct. 20, 1961), and was a refinement of the M20B. The fixed gear, fixed propeller M20D "Master" (TC: Oct 15, 1962) was introduced as an attempt to reach a lower price market, but most M20Ds have been converted to the M20C configuration.

Power was increased with the installation of an injected 200 hp Lycoming in the M20E (TC: Sep. 4, 1963). Next came the M20F (TC: Jul. 25, 1965), and a fuselage ten inches longer. The long body M20G "Statesman" (TC: Nov 13, 1967) was the last Mooney to be powered by the 180 hp carbureted Lycoming.

Although not in the M20 Series, the all-new pressurized M22 "Mustang" began a five-year production run in 1966, which totaled only 32 aircraft. These aircraft were powered by the turbocharged 310 hp Lycoming TIO-541-A1A engine.

From 1969 to 1973, the manufacturer changed ownership several times, but the basic M20 design was retained, and in 1973 returned to the market as the M20C, E, and F models.

In 1977 Roy Lopresti introduced the M20J "201" (TC: Sep 27, 1976) which attained 201 mph, still using 200 hp on the basic M20 airframe. In 1979 the M20K (TC: Nov 16, 1978) mounted a six-cylinder turbocharged 210 hp Continental under a lengthened nose and reached 231 mph.

The M20L, powered by an aviation certified Porsche engine with computerized single lever power control, was introduced in 1988 although only about 50 have been produced.

In 1989, the M20M "TLS", powered by a new 260 hp, 540 cubic inch turbocharged Lycoming, was introduced. This plane is the world's fastest four place production aircraft.

Beginning in mid 1991, production M20J aircraft were certified at a new maximum gross weight of 2900 lb., an increase over the former 2740 lb. Some late model existing M20Js may also be re-certifiable at the higher max. gross weight.

Questions regarding re-certification of existing M20Js should be referred to Mooney Aircraft Corporation.

In 1994 Mooney added the M20R `Ovation` to its product line, using the Teledyne Continental Motor (TCM) model IO-550-G5 normally aspirated engine. The basic airframe is like the TLS, however the interior had been completely up-dated. This new interior was added later to the TLS as standard equipment. In 2000 MAC added the "Ovation2" with same IO-550-G5 engine, and a new high performance two bladed McCauley propeller, replacing the 3- bladed on the previous Ovation. The avionics was up-dated to the latest Garmin 430 (530) array giving the panel a "glass cockpit look."

By popular demand, the M20K was re-introduced in 1997 as the Encore. New to this model is the Teledyne Continental Motors turbocharged intercooled 220 hp. TSIO-360-SB engine. Along with this improved engine is an additional 200 lbs. to the gross weight. Depending on how the aircraft is equipped, average payload is 650 lbs. The additional weight is supported with the TLS main gear and brakes. Wing and power loading changed slightly: Wing loading - 17.7 lbs/sq. ft.; Power loading - 14.1 lbs/hp. The increased hoursepower enhanced the climb and cruise performance by about 4%.

In February of 1999, Mooney introduced the M20S Eagle. This airplane is aerodynamically identical from the firewall aft to the M20R Ovation, but makes only 244 horsepower compared to the Ovation's 280 horsepower. The Eagle uses the same Continental IO-550 engine as the Ovation, but turns the engine at a maximum of 2400 rpm compared to the Ovation's 2500 rpm. Moreover, the Eagle comes with a two bladed McCauley constant speed propeller in place of the Ovations three bladed model. The M20 Eagle's maximum fuel load is 75 US gallons compared to 89 US gallons usable for the Ovation.

The 305 Rocket is a conversion produced by Rocket Engineering Corp. The conversion is on the Mooney M20K (231 & 252) aircraft. Rocket replaces the stock 210 HP TSIO-360 engine with a 520 cubic inch 305 HP turbocharged intercooled Continental TSIO-520-NB engine, along with a feathering three-blade prop.

The 300 Missile is also a conversion from Rocket Engineering. Based on the M20J airframe, Rocket replaces the IO-360 series engine with a Continental IO-550-A 300 HP normally aspirated engine along with a three blade full feathering prop.

CHAPTER 1. WEIGHT AND BALANCE

First Things First

This section addresses a critical flight planning area, the determination of payload (passengers and baggage) and usable fuel loading. Terminology is presented followed by discussions of reference datum and wing loading and a practical weight and balance problem. (A second critical flight planning area, the use of performance charts, is discussed in Chapter 3.)

Terminology

To minimize confusion over the definitions of various terms, we begin by referring to the "Weight and Balance Terminology" pages found in the General Section of current Mooney Pilot Operating Handbooks (POHs).

Arm	The horizontal distance from the reference datum to the center of gravity (CG) of an item or load.
Basic Empty Weight	The actual weight of the airplane and includes all operating equipment (including optional equipment) that has a fixed location and is actually installed in the aircraft. It includes the weight of unusable fuel and full oil. Note that installed optional equipment includes loose items such as the POH or tow bar.
Center of Gravity (CG)	The point at which an airplane (gear extended) would balance if suspended. CG distance from the reference datum is found by dividing the total moment by the weight of the airplane.
CG Arm	The CG arm is obtained by adding the airplane's individual moments and dividing by total weight.
CG in % MAC	Center of Gravity (location) expressed in percent of mean aerodynamic chord.
CG Limits	The extreme center of gravity locations within which the airplane must be operated at a given weight.

MAC Mean Aerodynamic Chord. ("Average" chord)

Maximum Weight The maximum authorized weight of the aircraft and its contents as listed in the aircraft specifications.

Moment The product of the weight of an item multiplied by its arm. (Moment divided by a constant, generally 1000, is used to simplify balance calculations by reducing the number of digits.)

Payload Weight of occupants, cargo and baggage.

Reference Datum An imaginary vertical plane from which all horizontal distances are measured for balance purposes. (See discussion on next page)

Standard Empty Weight Weight of a standard airplane including unusable fuel, full operating fluids (hydraulic oil, battery acid, deicer fluid, etc) and full oil.

Station A location along the airplane fuselage usually given in terms of distance (usually inches) from the reference datum.

Tare 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.

Unusable Fuel Fuel remaining after a run out test has been completed in accordance with government regulations.

Usable Fuel Fuel available for aircraft engine combustion or flight planning.

NOTE: 100LL weighs 5.82 lb/gal

Useful Load The basic empty weight subtracted from the maximum weight of the aircraft. This load consists of the pilot, crew if applicable, fuel, passengers, and baggage.

M20 Series Reference Datum

For all Mooneys, the reference datum plane is at fuselage station 0.00. On "short fuselage" M20, M20A, M20B, M20C, M20D and M20E models, fuselage station 0.00 is at the nose gear support bolt centerline.

On "long fuselage" models M20F, M20G, M20J, and M20K, fuselage station 0.00 is 5.00 in. aft of the centerline of the nose gear support bolts. With the new "longer fuselage" models M20L and M20M, fuselage station 0.00 is 13 in. aft of the centerline of the nose gear support bolts.

The leading edge of every Mooney wing is 33.00 in. aft of fuselage station 0.00. This explains why short, long, and longer fuselage Mooneys all have similar CG ranges when expressed as "inches aft of datum." See page 1-4, "CG ENVELOPES, M20 SERIES", which compares the center of gravity envelope limits for all M20 models. (The M20J envelope will be examined in detail later in this chapter.)

With its 10 in. longer fuselage, the M20F wheelbase also increased 5 in. Fuselage length grew 8 in. more with the M20J, and an additional 9 in. with the M20K, although the wheelbase remained unchanged.

Mounting the M20L and M20M engines required lengthening the fuselage structure forward of station 0.00. On these models the nose wheel was moved 8 in. forward for better propeller clearance, 12 in. was added at the baggage compartment, and remotely mounted avionics and batteries were moved farther aft in the tail cone to help offset the moment of the longer nose.

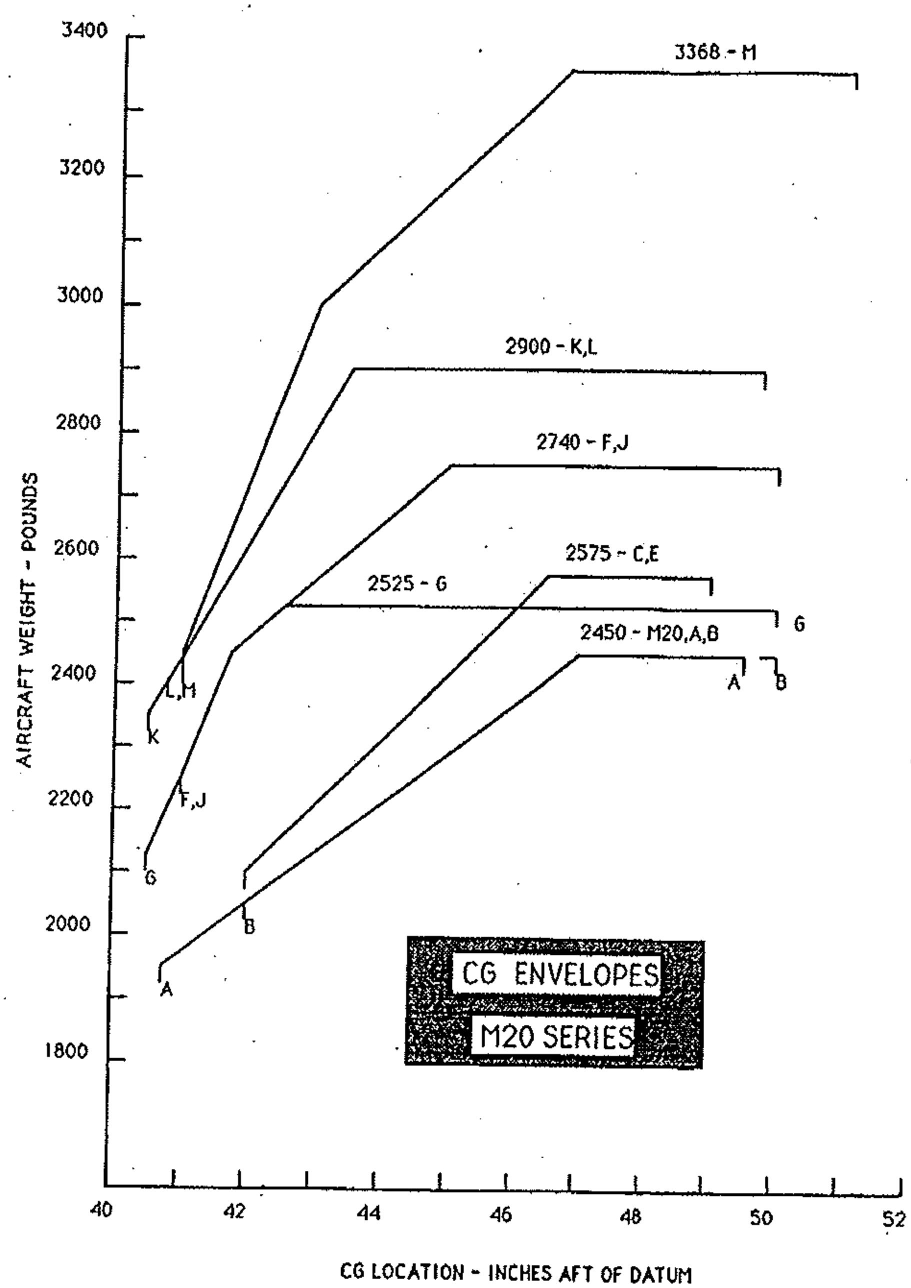
Wing Loading

Wing loading, in pounds per square foot (lb/sq ft), is determined by dividing wing area by max gross weight. As Mooneys have gotten heavier in recent years, wing areas have also increased slightly.

The M20K was introduced in 1979 with increases in wing span and mean aerodynamic chord (mac). The addition of sculptured M20J wing tips in 1981 increased its wingspan to that of the M20K. In 1991, maximum gross weight for new M20J's was increased from 2740 to 2900. A summary of wing areas, wing loading, and CG limits is shown in the table on page 1-5.

when weighing a/c it is Gear down -
- when gear swings up - CG moves aft.

Weight and Balance



wing span x MAC ≠ wing area
b/c the bottom side of fuselage also provides lift.

M20 SERIES - WING LOADING DATA

(bottom side ↑ lift due to prop blast.)

MODEL	Wing Span (ft-in)	MAC (in)	Wing Area (sq ft)	Max Gross (lb)	Wing Loading (lb/sq ft)	CG Limits (% MAC)
M20A,B	35-0	59.18	166.93	2450	14.7	15.0-8.72
M20C,E	35-0	59.18	166.93	2575	15.4	15.0-26.8
M20F	35-0	59.18	166.93	2740	16.4	13.4-28.7
M20G	35-0	59.18	166.93	2525	15.1	12.4-28.7
M20J,77-80	35-0	59.18	166.93	2740	16.4	13.4-28.7
M20J,81-90	36-1	59.18	168.42	2740	16.3	13.4-28.7
M20J,91-on	36-1	59.18	168.42	2900	17.2	13.4-28.7
M20K	36-1	61.00	174.80	2900	16.6	16.1-30.4
M20L	36-1	61.00	174.80	2900	16.6	16.8-30.4
M20M&R	36-1	61.00	174.80	3368	19.3	16.8-33.2

Weight and Balance Records

Procedures for determining loaded aircraft weight and moment for flight operations are documented in Section VI of current M20 series POHs.

The POH also contains worksheets and procedures for an FAA licensed mechanic to calculate a new empty weight and moment for the aircraft when the removal or addition of equipment causes the empty weight or center of gravity to change. A comprehensive list of all Mooney equipment available at the time of original delivery is in the POH, with checks indicating those factory items installed and included in the Mooney calculation of empty weight and balance data.

The FAA charges the aircraft owner and pilot with the responsibility of properly loading the aircraft for safe flight. Information presented in this section will enable you to carry out this responsibility and insure that your Mooney is loaded to operate within its prescribed weight and center of gravity (CG) limitations.

At the time of delivery, Mooney Aircraft Corporation provides the actual empty weight and center of gravity data, which is to be used for the computation of loadings for each individual aircraft. This as-delivered empty weight and CG (with gear extended) is tabulated in the Owners Weight and Balance Record, contained in the POH supplied with the aircraft. FAA regulations also require that any change in the original equipment affecting the empty weight and center of gravity be recorded in the Aircraft Log Book.

The Owners Weight and Balance Record is a convenient form for maintaining a permanent record of all such changes and will enable you to determine the current weight and balance status of the airplane for load scheduling. Remember that regardless of the empty weight and CG location, the Pilot In Command is responsible for insuring that his loaded aircraft is within weight and CG limits.

Loading Schedule Calculation (example)

It is Wednesday evening before your 500 mile round trip flight this brisk Fall weekend. There will be two couples in your 1983 M20J, N5687U (maximum certificated gross weight 2740 lbs), with baggage for two nights. The plane is topped off with 64 usable gallons of 100LL and safe in the hangar, but you will be checking it out tomorrow when you shoot some practice approaches with an IFR-current flying buddy.

Knowing that proper aircraft loading is essential for maximum flight performance and safety, you begin to work through the loading schedule calculation in POH Section VI to insure that N5687U will be within approved weight and CG limits for your trip. For convenience, you use an extra copy of the Problem Form from the Pilot Operating Handbook (POH). (See page 1-7.)

STEP 1. Referring to the last entry in the Owners Weight and Balance Record for N5687U, you fill in the empty weight (1834 lb) and moment (84.09 lb-in/1000). You recall that the empty weight includes full oil (8 QT/11.5 lb) and unusable fuel (2.5 gal/15 lb)

STEP 2. At 160 lb, you normally fly with the pilot's seat well forward, while your 180 lb "copilot" likes to sit further aft. You enter these weights in the Problem Form sub columns. With the POH Loading Computation Graph, page 1-8, use the following procedure to enter moment values:
Find your 160 lb weight on the left scale, cross horizontally to the sloping line representing the No. 1 seat in FWD POS and then vertically down to the bottom scale, where you read a moment value of 5.5. Repeat the procedure for the co-pilot using his 180 lb weight and the sloping line for the No. 2 seat in AFT POS, and obtain a moment value of 7.0. (Read moments; to the nearest .5 lb-in/1000.)

STEP 3. The rear seat passengers weigh 115 and 125 lb. Proceed as above entering weights, and moments (8.0 and 9.0) in the Problem Form.

useful load : 745.88

Empty wt : 2154.12
Arm - 44.74
moment 96369.46

MOONEY
M20J

SECTION VI
WEIGHT AND BALANCE

PROBLEM FORM

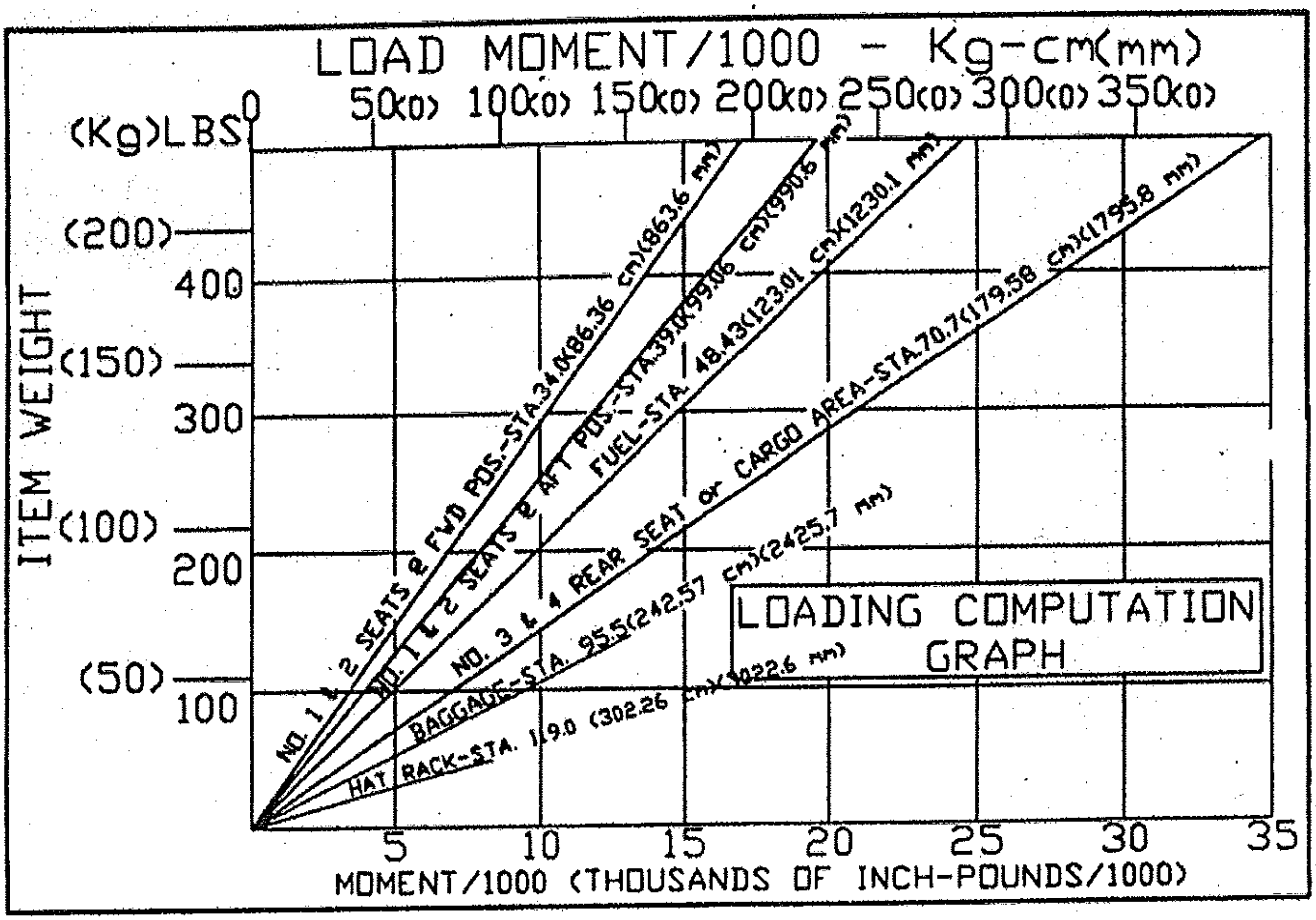
STEP	ITEM	SAMPLE PROBLEM WEIGHT (Kg) Lbs	SAMPLE PROBLEM MOMENT (Kg-cm /1000) lb-in /1000	YOUR PROBLEM WEIGHT (Kg) Lbs	YOUR PROBLEM MOMENT (Kg-cm /1000) lb-in /1000
1.	A/C Basic Empty Wt.(W)(from page 6-5) (Includes Full Oil)8 Qts.(7.6 Li)@STA.-11.5 (-29.2 cm) (Oil sump assumed FULL for all flights)	(793.8) 1830 1750	(887.38) 76.53 77.02		
2.	Pilot Seat (#1) *	(77.1) 170	(69.1) (2nd Pos) 6.0		
	Co-Pilot Seat (#2) *	(77.1) 170	(66.4) (2nd Pos) 5.78		
3.	Left Rear Seat (#3) or Cargo Area	(77.1) 170	(138.5) 12.02		
	Right Rear Seat (#4) or Cargo Area	(77.1) 170			
4	Fuel (Max. Usable - 64 Gal. (242.3 li) 384 lbs. (174.2 Kg)@Sta 48.43(123.0 cm)	(141.5) 312	(174.1) 15.11		
5.	Baggage (Max. 120 Lbs(54.4 cm)@Sta.95.5 (242.6 cm)	(40.9) 110	(121.0) 10.51		
	Hat Rack (Max. 10 Lbs(4.54 Kg)@Sta. 119.0 (302.3 cm)		(4.1) .36		
6.	Loaded Aircraft Weight	(1218) 2685	X		X
	Total Moment/1000	X	(1463.7) 127	X	
7.	Refer to Center of Gravity Moment Envelope, to determine whether your A/C loading is acceptable.				

* Obtain the moment/1000 value for each seat position (FWD, MID or AFT) from loading computation graph.

J29-PRBFRM

CAUTION

Cargo loaded in rear seat area, with seat backs folded down, should have center of gravity over fuselage station 70.7.



LOAD MOMENT/1000 - Kg-cm(mm)
0 50(0) 100(0) 150(0) 200(0) 250(0) 300(0) 350(0)
(Kg)LBS
(200)
400
(150)
300
(100)
200
(50)
100
ITEM WEIGHT
NO. 1 & 2 SEATS @ FWD POS-STA.34.0(86.36 cm)(863.6 mm)
NO. 1 & 2 SEATS @ AFT POS-STA.39.0(99.06 cm)(990.6 mm)
FUEL-STA. 48.43(123.01 cm)(1230.1 mm)
NO. 3 & 4 REAR SEAT or CARGO AREA-STA.70.7(179.58 cm)(1795.8 mm)
BAGGAGE-STA. 95.5(242.57 cm)(2425.7 mm)
HAT RACK-STA. 119.0 (302.26 cm)(3022.6 mm)
LOADING COMPUTATION GRAPH
5 10 15 20 25 30 35
MOMENT/1000 (THOUSANDS OF INCH-POUNDS/1000)

ISSUED 1 - 96

STEP 4. With four adults and baggage you cannot carry full fuel within allowable gross weight, so you use a trial value of 50 gal for the fuel load. Proceeding as above, but using the sloping line for fuel and a figure of 6 lb/gal for 100LL, (more on this later), results in values of 300 lb and 14.5 lb-in/1000.

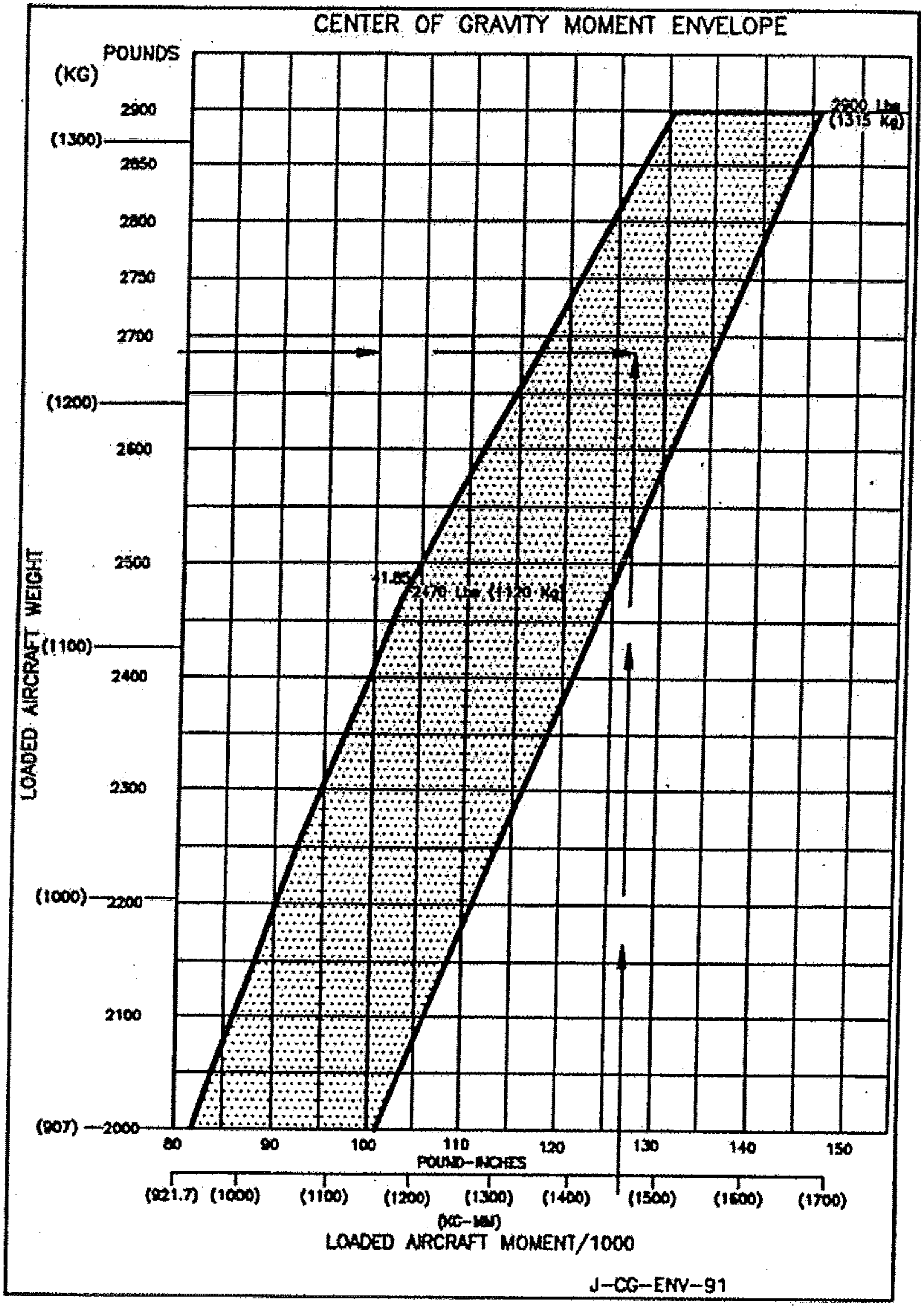
STEP 5. Using the Loading Computation Graph for 75 lb in the baggage area and 5 lb in the hat rack, you obtain moments of 7.0 and 0.5. (Actually 0.6 by calculation)

STEP 6. You add up the weight column, obtaining a gross weight of 2794 lb, and quickly see that your trial-loading schedule is 54 lb OVERWEIGHT (2794 - 2740 = 54). The ladies are barely speaking to you because of your 40 lb baggage limit per couple, and you know you must plan to take off with less fuel on board, but how much less?

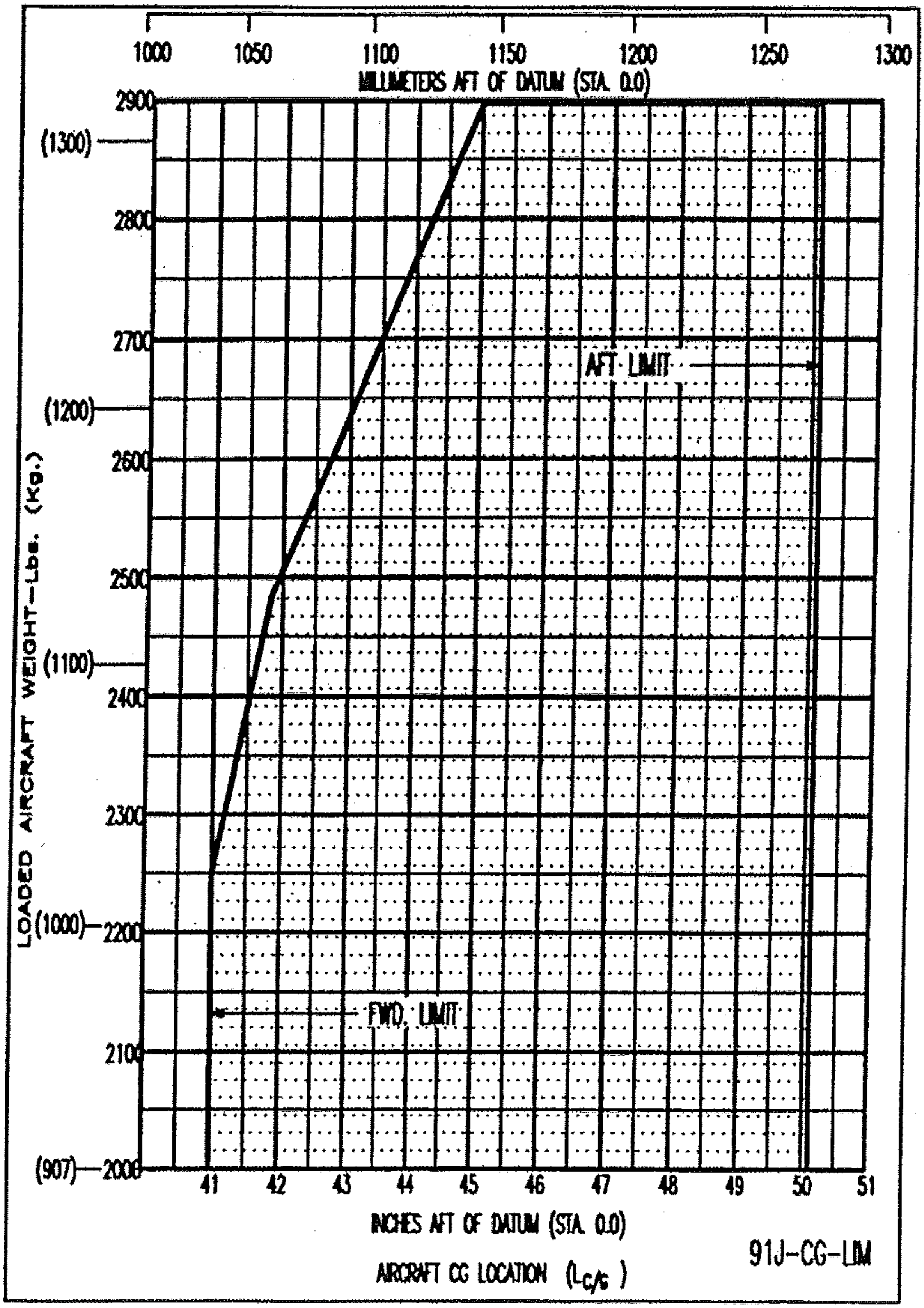
More quick arithmetic shows that the weight available for fuel is 246 lb (300 - 54 = 246). Dividing 246 by 6 would give 41 gal, but you remember something else from the MAPASF program . . . 100LL weighs 5.82 not 6.0 lb/gal (a difference of 3%). The calculation thus becomes 246 divided by 5.82 = 42.3 gal of 100LL at takeoff, and the corrected fuel moment becomes 12.0.
Allowing 1.3 gal for start, taxi, and run-up means you could have 43.6 gal on board at engine start and still be within the allowable M20J gross weight at takeoff.

STEP 7. Now for the "moment of truth". You are within allowable gross weight, but must still check that the total moment is within the CG envelope on page 1-10. Addition of the last column (with corrected fuel moment) gives a total moment of 133.2 lb-in/1000, apparently within the envelope. The maximum allowable moment can be calculated exactly by multiplying the maximum gross weight (2740 lb) by its arm at the aft CG limit (50.1 in), which gives 137,274 lb-in or 137.3 lb-in/1000. It is now apparent that our loading schedule results in a total moment which is indeed within the allowable limits.

Now all that remains is to fly off 21 gallons during your IFR practice approaches. Remember to recheck the loading schedule if your copilot changes places with one of your passengers, if any heavy souvenirs find their way into the baggage area, or if unexpectedly warm weather should materialize.


CENTER OF GRAVITY MOMENT ENVELOPE
POUNDS
(KG)
2900
(1300)
2850
2800
2750
2700
(1200)
2600
2500
(1100)
2400
2300
(1000)
2200
2100
(907)
2000
LOADED AIRCRAFT WEIGHT
2900 Lbs (1315 Kg)
2470 Lbs (1120 Kg)
80
90
100
110
120
130
140
150
POUND-INCHES
(921.7)
(1000)
(1100)
(1200)
(1300)
(1400)
(1500)
(1600)
(1700)
(KG-MM)
LOADED AIRCRAFT MOMENT/1000
J-CG-ENV-91

M20J - CENTER OF GRAVITY LIMITS ENEVELOPE



CHAPTER 2. AIRSPEED LIMITATIONS

Why Do We Care?

Airspeed control, one of the most important flying skills, is especially important in Mooney operations. This section is designed to aid in understanding and flying proper airspeeds through a review of terminology, maneuvering speed, and other airspeed limitations. Values for the M20 series are compared, "Important Speed" charts for individual models are provided, and target airspeeds for flight operations are discussed.

Airspeed Terminology and Symbols

M20 airspeed limitations are defined below, with commentary.

V_a **Maneuvering Speed** - The maximum speed at which application of full available aerodynamic control will not overstress the airplane. Since many handbooks list only the maneuvering speed at max gross weight, remember that at lighter weights maneuvering speed is less. (See discussion on page 2-2 "How Maneuvering Speed Works")

V_{fe} **Maximum Flap Extended Speed** - The highest speed permissible with wing flaps in a prescribed extended position. Some M20J/205s allow higher speeds for up to 15° flap extension. Top of white -

V_{le} **Maximum Landing Gear Extended Speed** - The maximum speed at which an aircraft can be safely flown with the landing gear extended. Significantly higher gear-extended speeds are allowed with newer M20s.

$V_{lo(ext)}$ **Maximum Speed for Gear Extension** - The maximum speed at which the landing gear can be safely extended.

$V_{lo(ret)}$ **Maximum Speed for Gear Retraction** - The maximum speed at which the landing gear can be safety retracted. For all M20C and later models, the gear retraction speed is less than either gear extended or gear extension speeds.

VNE based on S ⇒ Stall speed vs angle of Bank
Vs w/ 30° adds 2.5 Kts to Vs
45° adds 9 Kts to Vs
60° adds 22.5 Kts to Vs
150% of VNE to certify a/c

V_{ne} **Never Exceed Speed** - The INDICATED airspeed that may not be exceeded at any time. This airspeed is the "red radial" at the top of the yellow arc on the airspeed indicator.

- due to flutter, structural damage

V_{no} **Maximum Structural Cruising Speed** - The INDICATED airspeed that should not be exceeded except in smooth air and then only with caution. This airspeed is the "top of the green arc".

V_s **Stalling Speed, Cruise Configuration** - The minimum steady flight speed at which the airplane is controllable. This speed becomes lower as aircraft weight decreases.

- at gross weight - no power, clean - forward CG - 1G.

V_{so} **Stalling Speed, Landing Configuration** - The minimum steady flight speed in the landing configuration at which the airplane is controllable. This speed also decreases as aircraft weight decreases and must be remembered during short field operations.

V_x **Best Angle-of-Climb Speed, Gear & Flaps Up** - The airspeed, which delivers the greatest gain of altitude in the shortest possible horizontal distance. This is generally the highest speed to be flown during obstacle clearance takeoffs and VFR go-arounds.

V_y **Best Rate-of-Climb Speed, Gear & Flaps Up** - The airspeed that delivers the greatest gain of altitude in the shortest possible time. However, consider the advantages of higher airspeed cruise climbs.

How Maneuvering Speed Works

"Maneuvering speed", V_a, is that speed at which the airplane will stall before reaching its structural design load limit, 3.8 positive Gs in our **normal category** Mooneys. Because stall speed for a given configuration varies as the square root of the "G" load, our flaps up maneuvering speed will be the square root of 3.8 (about 1.95) times the stall speed in cruise configuration.

The "bottom of the green arc" stall speed is for the cruise configuration **at**

maximum gross weight. Since stall speed also varies as the square root of the airplane weight, for any weight less than maximum gross the actual stall speed will be less. (See page 2-4). Therefore, maneuvering speed becomes 1.95 times the actual lower stall speed of the lighter aircraft.

The airplane must not, at any weight, be subjected to more than its structural design load limit of 3.8 Gs. Flying at the correct maneuvering speed insures that the wing will not generate airframe loads (lift) of over 3.8 Gs, regardless of turbulence or abrupt control inputs. The POH maneuvering speed value is correct only at maximum gross weight. When actual in-flight weight is less than maximum gross, the maneuvering speed we fly must be reduced from the POH value.

A rule of thumb for the M20 series is to reduce the POH maneuvering speed value by 5 knots for every 200-pound reduction in aircraft weight. For example, if 400 pounds less than max gross, in turbulent air fly 10-knots/11 mph slower than POH maneuvering speed.

WARNING!

DO NOT EXTEND FLAPS IN TURBULENCE. GEAR MAYBE LOWERED, BUT ALWAYS SLOW TO RETRACTION SPEED TO RAISE GEAR.

Takeoffs, Landings, and Go-arounds

Takeoffs, landings, and go-arounds each have target airspeed for safe execution. Always follow POH procedures and avoid higher speeds. The Mooney takeoff configuration is partial flaps, 15° for M20J and earlier models, 10° for M20K and later, used with maximum available power. The pilot should "lighten the nose wheel" (except in strong cross winds) on the takeoff run, and apply back pressure as needed to achieve liftoff and "50 ft" speeds for the aircraft weight as given in POH performance charts.

Owner's Manuals for pre-M20J models typically provide a 10 mph liftoff speed range. For steady winds, liftoff should be near the lower value, and the "50 ft" speed should be about 10 mph/kt above the upper range value. In gusty winds, liftoff should be near the higher value, using a pitch input to prevent re-contacting the runway, and a coordinated turn into the wind to climb out over the runway.

During final approaches, a major concern is excessive speed. This is commonly followed by a touchdown on all three wheels, and the screeching of tires as heavy braking is initiated before sufficient weight has been transferred to the landing gear.

If the plane is held off for a touchdown at the proper speed, a lengthy float in ground effect will result which can be particularly challenging in cross winds.

"50 ft" approach speed as a function of weight is tabulated on current POH performance charts. It is rarely necessary to exceed this speed, which is 1.3 V_{so}. For short field landings, 1.2 V_{so} is the target on a stabilized, slightly steeper approach. The standard technique of controlling airspeed with aircraft pitch attitude (left hand on yoke), and rate of descent with power (right hand on throttle) should be used for Mooney approaches and go-arounds.

A properly executed go-around is the mark of a skilled pilot, as he establishes a positive vertical rate, and safely transitions from a low-power/descending/gear and flaps down configuration to a high-power/climbing/clean configuration. The go-around requires simultaneous application of power and pitch inputs to maintain the same airspeed as that flown on short final. As the go-around is initiated, Mooneys in landing trim require ample nose down trimming and right rudder to offset the high "P factor". Flaps may be set to the takeoff position, and with a positive rate of climb (ROC) the gear is retracted. Finally, accelerate to V_y (best ROC) and retract the flaps.

M20 Series Limiting Airspeeds

The following table, extracted from Mooney Aircraft Specification 2A3, shows limiting airspeeds throughout the development of the M20 Series. Ranges indicate limits for early and late models. The M20M, with its higher wing loading, has a higher stall speed and therefore also a higher maneuvering speed. Increases in gear extension and gear extended speeds, but not gear retraction speeds, have accompanied redesign of the 205, 252, and TLS/Ovation undercarriages.

Va= wing will stall prior to reaching 3.8 G's.

M20 SERIES - SUMMARY of AIRSPEED LIMITATIONS

	M20, A,B	M20C, D,E	M20F M20G	M20J,	M20M K,L	M20K 252	M20R
AIRSPEED LIMITATION			All Airspeeds in Knots				
V_a Maneuvering	113	115	117	117	123	118	127
V_{fe} Flaps Extended	87	87-109	91-109	109	109	112	110
V_{le} Gear Extended	104	104	104	130-162	165	165	165
$V_{lo(ext)}$ Gear Extension	104	104	104	129-138	139	140	140
$V_{lo(ret)}$ Gear Retraction	104	104	104	104	104	104	104
Vne Never Exceed	159	164-174	174	195	195	196	196
V_{no} Max Struct Cruise	130	130-152	152	174	174	174	174

Important Speed Charts

While pilots must always be mindful of the limiting airspeeds discussed above, it is equally important to fly the correct airspeed for the operation at hand. The Pilot Operating Handbooks and Owners Manuals for the M20 series have been analyzed in depth by the MAPASF, with the specific objective of developing the following "Important Speed" charts for each model in the M20 series. This study also highlighted the great differences in organization and information content between early and current manuals.

In some cases, airspeed values have been enclosed in parentheses, to indicate data, which has been calculated, using accepted FAA methods, when the Owners Manual or Pilot Operating Handbook did not contain the desired information.

When studying or utilizing data from these charts, pilots should look for and recognize patterns, i.e., 50' agl speeds for normal takeoffs and landings are the same. This is also true for 50' agl speeds for maximum performance takeoffs and short field landings. Note also that the initial speed for a balked landing is essentially the target airspeed for short final.

NOTE

EVERY EFFORT HAS BEEN MADE TO ACCURATELY CITE AND TABULATE MATERIAL FROM THE M20 SERIES PILOT OPERATING HANDBOOKS AND OWNERS MANUALS, BUT MAPA SAFETY FOUNDATION CANNOT BE RESPONSIBLE FOR ERRORS IN THE TRANSCRIPTION OR OTHER ANALYSIS OF HANDBOOK/MANUAL DATA. THE FOUNDATION STRONGLY ADVISES PILOTS TO BECOME FAMILIAR WITH THE SPECIFIC HANDBOOK/MANUAL FOR THEIR AIRCRAFT, SINCE THOSE DOCUMENTS ARE THE FAA APPROVED SOURCE OF OPERATING INFORMATION FOR THE M20 SERIES.

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MOONEY MARK 20A
IMPORTANT SPEEDS

	Flight Operation	mph @ 2450lb	Manual reference
1.	Power-off stall, gear down, flaps 33°	57	AFM-2
2.	Power-off stall, gear and flaps up	62	AFM-2
3.	Normal takeoff	65-75	17
4.	Normal takeoff 50' agl	(80)	-
5.	V_y, clean, full throttle, 2700 rpm, sea level	96	17
6.	Maximum performance takeoff, flaps 15°	60	18
7.	Maximum performance takeoff 50' agl	70	18
8.	V_x, clean, full throttle, 2700 rpm, sea level	75	18
9.	Normal landing 50' agl	80	23
10.	Short field landing 50' agl	70	24
11.	Balked landing, flaps 33°, gear down	(80)	-
12.	Normal climb, 25"/2500 rpm or full throttle/2600 rpm	115-120	17
13.	V_a, Maneuvering, maximum gross weight	130	AFM-2

References: 1960 Mark 20A Owners Manual
1959 Mark 20A Airplane Flight Manual

Recommended cruise operating range: 2300-2500 rpm

MOONEY M20B/MARK 21
IMPORTANT SPEEDS

	Flight Operation	mph @ 2450lb	Manual reference
1.	Power off stall, gear down, flaps 33°	57	AFM-2
2.	Power off stall, gear and flaps up	62	AFM-2
3.	Normal takeoff	65-75	22
4.	Normal takeoff 50' agl	(80)	-
5.	V_y, clean, full throttle, 2700 rpm, sea level	96	24
6.	Maximum performance takeoff, flaps 15°	60	25
7.	Maximum performance takeoff 50' agl	70	25
8.	V_x, clean, full throttle, 2700 rpm, sea level	75	25
9.	Normal landing 50' agl	80	30
10.	Short field landing 50' agl	70	31
11.	Balked landing, flaps 33°, gear down	(80)	-
12.	Normal climb, 25"/2500 rpm or full throttle/2600 rpm	115-120	24
13.	V_a, Maneuvering, maximum gross weight	130	AFM-2

References: 1961 Mark 20B Owners Manual
1960 Mark 20B Airplane Flight Manual

Recommended cruise operating range: 2300-2500 rpm

MOONEY M20C/RANGER
IMPORTANT SPEEDS

	Flight Operation	mph @ 2450lb	Manual reference
1.	Power off stall, gear down, flaps 33°	57	AFM-2
2.	Power off stall, gear and flaps up	62	AFM-2
3.	Normal takeoff	65-75	22
4.	Normal takeoff 50' agl	(80)	-
5.	V_y, clean, full throttle, 2700 rpm, sea level	96	24
6.	Maximum performance takeoff, flaps 15°	65	25
7.	Maximum performance takeoff 50' agl	70	25
8.	V_x, clean, full throttle, 2700 rpm, sea level	75	25
9.	Normal landing 50' agl	80	30
10.	Short field landing 50' agl	70	31
11.	Balked landing, flaps 33°, gear down	(80)	-
12.	Normal climb, 25"/2500 rpm or full throttle/2600 rpm	115-120	24
13.	V_a, Maneuvering, maximum gross weight	130	AFM-2

References: 1962 Mark 20C Owners Manual
1962 Mark 20B Airplane Flight Manual

Recommended cruise operating range: 2350-2500 rpm

MOONEY M20E/SUPER 21
IMPORTANT SPEEDS

	Flight Operation	mph @ 2575lb	Manual reference
1.	Power off stall, gear down, flaps 33°	57	39
2.	Power off stall, gear down, flaps 15°	64	39
3.	Power off stall, gear and flaps up	67	39
4.	Normal takeoff	65-75	21
5.	Normal takeoff 50' agl	(80)	-
6.	V_y; clean, full throttle, 2700 rpm, sea level/10,000'	113/102	33
7.	Maximum performance takeoff, flaps 15°	65	21
8.	Maximum performance takeoff 50' agl	80	21
9.	V_x, clean, full throttle, 2700 rpm, sea level	80	21
10.	Normal landing 50' agl	80	24
11.	Short field landing 50' agl	67	40
12.	Balked landing, flaps 33°, gear down	(80)	-
13.	Normal climb, 25"/2500 rpm or full throttle/2600 rpm	115-120	21
14.	Max glide range, windmilling/stopped, 2575 lb	105/100	39
15.	V_a, Maneuvering, maximum gross weight	130	AFM

Reference: Nov 1965 M20E/Super 21 Owners Manual
Recommended cruise operating range: 2350-2500 rpm
Avoid continuous cruise operations within 2100-2350 rpm

MOONEY M20F/EXECUTIVE
IMPORTANT SPEEDS

	Flight Operation	mph @ 2740lb	Manual reference
1.	Power off stall, gear down, flaps 33°	62	6-6
2.	Power off stall, gear down, flaps 15°	64	6-6
3.	Power off stall, gear and flaps up	68	6-6
4.	Normal takeoff	65-75	3-13
5.	Normal takeoff 50' agl	(80)	-
6.	V_y, clean, full throttle, 2700 rpm, sea level/10,000'	113/102	3-14
7.	Maximum performance takeoff, flaps 15°	65	21
8.	Maximum performance takeoff 50' agl	80-90	3-14
9.	V_x, clean, full throttle, 2700 rpm, sea level	94	3-14
10.	Normal landing 50' agl	80	3-23
11.	Short field landing 50' agl	(74)	-
12.	Balked landing, flaps 33°, gear down	(80)	-
13.	Normal climb, 26"/2600 rpm	115-120	3-14
14.	Max glide range, windmilling/stopped, 2740 lb	(105/100)	-
15.	V_a, Maneuvering, 2740/2300 lb	135/(104)	4-3

Reference: M20F Owners Manual, issued 1-74
Recommended cruise operating range: 2350-2500 rpm
Avoid continuous cruise operations within 2100-2350 rpm

MOONEY M20G/STATESMAN
IMPORTANT SPEEDS

	Flight Operation	mph @ 2525lb	Manual reference
1.	Power off stall, gear down, flaps 33°	61	6-6
2.	Power off stall, gear down, flaps 15°	63	6-6
3.	Power off stall, gear and flaps up	65	6-6
4.	Normal takeoff	65-75	3-12
5.	Normal takeoff 50' agl	(80)	-
6.	V_y, clean, full throttle, 2700 rpm, sea level/10,000'	101/87	3-13
7.	Maximum performance takeoff, flaps 15°	65	3-12
8.	Maximum performance takeoff 50' agl	81	3-13
9.	V_x, clean, full throttle, 2700 rpm, sea level	81	3-13
10.	Normal landing 50' agl	80	3-19
11.	Short field landing 50' agl	(71)	-
12.	Balked landing, flaps 33°, gear down	(80)	-
13.	Normal climb, 26"/2600 rpm	105-110	3-13
14.	Max glide range, wind milling/stopped, 2525 lb	(105/100)	-
15.	V_a, Maneuvering, maximum gross weight	135	5-3

Reference: M20G Owners Manual, issued 10-67
Recommended cruise operating range: 2300-2500 rpm
Avoid continuous cruise operations within 2000-2250 rpm

MOONEY M20J/201
IMPORTANT SPEEDS

Flight Operation	kias @ 2740 lb	Handbook Reference
1. Power off stall, gear down, flaps 33°	54	5-12
2. Power off stall, gear down, flaps 15°	60	5-12
3. Power off stall, gear and flaps up	61	5-12
4. Normal takeoff	63	4-9,5-13
5. Normal takeoff 50' agl	71	4-9,5-13
6. V_y, clean, full throttle, 2700 rpm, sea level/10,000'	88/82	5-17
7. Maximum performance takeoff, flaps 15°	62	4-10,5-4
8. Maximum performance takeoff 50' agl	66	4-10,5-4
9. V_x, clean, full throttle, 2700 rpm, sea level/10,000'	69/71	4-10
10. Normal landing 50' agl	71	5-31
11. Short field landing 50' agl	65	5-32
12. Balked landing, flaps 33°, gear down	65	4-14
flaps up, gear down	73	4-14
13. Normal climb, 26"/2600 rpm	91-100	4-10
14. Max glide range, wind milling, 2740/2300 lb	91/85	3-6
15. V_a, Maneuvering, 2740/2250 lb	116/103	fig 2-1

IMPORTANT! Speed for best Rate of Climb varies with Configuration

Flaps up, gear up (V_y)	88	5-17
Flaps up, gear down	73	4-14
Flaps 15°, gear down	71	4-9
Flaps 33°, gear down	65	4-14

Reference: M20J POH, issued 9-4-81 with revision C, 3-7-84 Avoid continuous operations within 1500-1950 rpm @ MP less than 15"

MOONEY M20K/231
IMPORTANT SPEEDS

	Flight Operation	kias @ 2900lb	POH reference
1.	Power off stall, gear down, flaps 33°	56	5-15
2.	Power off stall, gear down, flaps 10°	60	5-15
3.	Power off stall, gear and flaps up	61	5-15
4.	Normal takeoff	64	4-10
5.	Normal takeoff 50' agl	74	5-16
6.	V_y, clean, 40", 2700 rpm, sea level/15,000'	96/83	4-11
7.	Maximum performance takeoff, flaps 10°	64	4-10
8.	Maximum performance takeoff 50' agl	68	4-10
9.	V_x, clean, 40", 2700 rpm, sea level/15,000'	71/76	4-10
10.	Normal landing 50' agl	75	4-15
11.	Short field landing 50' agl	69	4-15
12.	Balked landing, flaps 33°, gear down	77	4-15
	flaps up, gear down	94	4-15
13.	Normal climb, 33"/2600 rpm	96-113	4-11
14.	Maximum glide range, wind milling, 2900/2300	87/76	3-10
15.	V_a, Maneuvering, 2900/2300 lb	118/101	2-3

IMPORTANT! Speed for best Rate of Climb varies with Configuration

Flaps up, gear up (V_y)	96	4-11
Flaps 10°, gear down	68	4-10

Reference: M20K POH, issued 11-16-78 with revision F, 3-7-84

MOONEY M20K/252
IMPORTANT SPEEDS

	Flight Operation	kias @ 2900 lb	POH ref.
1.	Power off stall, gear down, flaps 33°	59	5-14
2.	Power off stall, gear down, flaps 10°	60	5-14
3.	Power off stall, gear and flaps up	61	5-14
4.	Normal takeoff	67	4-15
5.	Normal takeoff 50' agl	74	5-15
6.	V_y, clean, 36",2700 rpm, sea level/15,000'	96	5-17
7.	Maximum performance takeoff speed, flaps 10°	67	4-15
8.	Maximum performance takeoff 50' agl	74	4-10
9.	V_x, clean, 36', 2700 rpm, sea level/15,000'	71/76	4-16
10.	Normal landing 50' agl	75	4-22
11.	Short field landing 50' agl	69	4-15
12.	Balked landing, flaps 33°, gear down	77	4-21
	Flaps up gear down	94	4-21
13.	Normal climb, 32", 2500 rpm	95/115	4-15
14.	Max glide range, wind milling, 2900/2300 lb	87 / 76	3-17
15.	V_a, Maneuvering, 2900/2300 lb	118 / 101	2-3

Important! Speeds for best Rate of Climb vary with configuration:

Flaps up, gear up (Vy)	96	5-17
Flaps 10 degrees, gear down	77	4-21

Reference: M20K POH, issued 12-16-85. Revision C, 5-29-87

MOONEY M20L/PFM
IMPORTANT SPEEDS

	Flight Operation	kias 2900lb	POH reference
1.	Power off stall, gear down, flaps 33°	57	5-11
2.	Power off stall, gear down, flaps 10°	62	5-11
3.	Power off stall, gear and flaps up	63	5-11
4.	Normal takeoff	65-70	4-12
5.	Normal takeoff 50' agl	80	4-12
6.	V_y, clean, full throttle, 2343 rpm, sea level/10,000'	96/89	4-4
7.	Maximum performance takeoff speed, flaps 10°	65	4-12
8.	Maximum performance takeoff 50' agl	78	4-4
9.	V_x, clean, full throttle, 2343 rpm, sea level/10,000'	75/78	4-4
10.	Normal landing 50' agl	75	4-4
11.	Short field landing 50' agl	70	4-4
12.	Balked landing, flaps 33°, gear down	75	4-15
	flaps up, gear down	90	4-15
13.	Normal climb, 2343 rpm	90-100	4-13
14.	Maximum glide range, wind milling, 2900/2300	87/74	3-14
15.	V_a, Maneuvering, 2900/2092 lb	117/100	4-4

IMPORTANT! Speed for best Rate of Climb varies with Configuration

Flaps up, gear up (V_y)	96	4-4
Flaps 10°, gear down	75	4-4

Reference: M20L Information Manual, issued 2-88

MOONEY M20M/TLS
IMPORTANT SPEEDS

	Flight Operation	kias @ 3200 lb	kias @ 3368 lb	POH ref.
1.	Power off stall, gear down, flaps 33°	59	59	5-13
2.	Power off stall, gear down, flaps 10°	63	64.5	5-13
3.	Power off stall, gear and flaps up	65	66.5	5-13
4.	Normal takeoff	65	66	5-14
5.	Normal takeoff 50' agl	80	80	5-14
6.	V_y, clean, full throttle, 2575 rpm, sea level	105	105	4-14
7.	Maximum performance takeoff speed, flaps 10°	65	65	4-13
8.	Maximum performance takeoff 50' agl	75	75	4-13
9.	V_x, clean, full throttle, 2575 rpm, sea level	80	85	4-14
10.	Normal landing 50' agl	80	not auth	5-25
11.	Short field landing 50' agl	75	not auth	4-19
12.	Balked landing, flaps 33°, gear down	85	not auth	4-18
13.	Normal climb, 34", 2400 rpm	120	120	5-17
14.	Max glide range, wind milling, 3368/3200/2600 lb	91.5 / 89 / 80		3-15
15.	V_a, Maneuvering, 3368/3200/2400 lb	126 / 123 / 106		4-4

Reference: M20M Information Manual, issued 6-89

MOONEY MISSILE
IMPORTANT SPEEDS

	Flight Operation	kias @ gross wt.
1.	Power off stall, gear down, flaps 33°	56
2.	Power off stall, gear down, flaps 10°	60
3.	Power off stall, gear and flaps up	61
4.	Normal takeoff	64
5.	Normal takeoff 50' agl	74
6.	V_y, clean, full throttle, 2650 rpm, sea level	96
7.	Maximum performance takeoff speed, flaps 10°	64
8.	Maximum performance takeoff 50' agl	68
9.	V_x, clean, full throttle, 2650 rpm, sea level	84
10.	Normal landing 50' agl	75
11.	Short field landing 50' agl	69
12.	Balked landing, flaps 33°, gear down	84
13.	Normal climb, FT, 2600 rpm	96-115
14.	Max glide range, wind milling	92-96
15.	V_a, Maneuvering,	118-101

Reference: Rocket Engineering

MOONEY ROCKET
IMPORTANT SPEEDS

	Flight Operation	kias @ gross wt.
1.	Power off stall, gear down, flaps 33°	56
2.	Power off stall, gear down, flaps 10°	60
3.	Power off stall, gear and flaps up	61
4.	Normal takeoff	70
5.	Normal takeoff 50' agl	80
6.	V_y, clean, 38 mp, 2650 rpm, sea level	107
7.	Maximum performance takeoff speed, flaps 10°	64
8.	Maximum performance takeoff 50' agl	75
9.	V_x, clean, 38 mp, 2650 rpm, sea level to 15,000	84
10.	Normal landing 50' agl	80
11.	Short field landing 50' agl (3200 lbs. Max)	75
12.	Balked landing, flaps 33°, gear down	84
13.	Normal climb, 35" mp, 2500 rpm	107-130
14.	Max glide range, feathered, 3200/3150 lb.	90
15.	V_a, Maneuvering, 3200/3150 lb.	118-101

Reference: Rocket Engineering

MOONEY M20/R OVATION
IMPORTANT SPEEDS

	Flight Operation	kias @ 3000 lb	kias @ 3368 lb	POH ref.
1.	Power off stall, gear down, flaps 33°	55.5	59	5-12
2.	Power off stall, gear down, flaps 10°	61	64.5	5-12
3.	Power off stall, gear and flaps up	63	66.5	5-12
4.	Normal takeoff	64	66	5-13
5.	Normal takeoff 50' agl	78	80	5-13
6.	V_y, clean, full throttle, 2500 rpm, sea level	105	105	4-11
7.	Maximum performance takeoff speed, flaps 10°	64	66	4-11
8.	Maximum performance takeoff 50' agl	78	80	4-11
9.	V_x, clean, full throttle, 2500 rpm, sea level	85	85	4-11
10.	Normal landing 50' agl (3200 lbs. Max)	75	not auth	5-24
11.	Short field landing 50' agl (3200 lbs. Max)	70	not auth	4-15
12.	Balked landing, flaps 33°, gear down	85	not auth	4-15
13.	Normal climb, 24", 2400 rpm	120	120	4-11
14.	Max glide range, wind milling, 3368/3200/2600 lb	91.5 / 89 / 80		3-10
15.	V_a, Maneuvering, 3368/3300/2400 lb	127 / 126 / 108		2-3

Reference: M20R Information Manual, issued 1-95 Rev. D.

MOONEY M20/S EAGLE
IMPORTANT SPEEDS

	Flight Operation	kias @ 2600 lb	kias @ 3200 lb	POH ref.
1.	Power off stall, gear down, flaps 33°	53	57.5	5-12
2.	Power off stall, gear down, flaps 10°	58	6 3.5	5-12
3.	Power off stall, gear and flaps up	59	65	5-12
4.	Normal takeoff	68	76	5-13
5.	Normal takeoff 50' agl	76	83	5-13
6.	V_y, clean, full throttle, 2400 rpm, sea level	100	100	4-12
7.	Maximum performance takeoff speed, flaps 10°	75	75	4-4
8.	Maximum performance takeoff 50' agl	75	75	4-11
9.	V_x, clean, full throttle, 2400 rpm, sea level	85	85	4-14
10.	Normal landing 50' agl (3200 lbs. Max)	68	75	5-24
11.	Short field landing 50' agl (3200 lbs. Max)	65	70	4-15
12.	Balked landing, flaps 33°, gear down	80	80	4-15
	Balked landing, flaps 10 , gear down	85	85	
13.	Normal climb, 24", 2400 rpm	120	120	4-12
14.	Max glide range, wind milling, 3200/2900/2600 lb	89 / 84.5 / 80		3-10
15.	V_a, Maneuvering, 3200/2900/2430 lb	124 / 118 / 109		2-3

Reference: M20S Information Manual, issued 1-99 Rev.

Mooney Aircraft Pilots Association Safety Foundation

MAPA SAFETY FOUNDATION

FLIGHT CURRICULUM - TARGET AIRSPEED MATRIX

		M20C	M20E	M20F	M20G	M20J	M20K	M20M	M20R	M20S
Para.		mph	mph	mph	mph	kt	kt	kt	kt	kt
3.5.a	liftoff	70	70	70	75	63	64	65	66	75
3.5.b	takeoff 50' agl	80	80	80	80	71	75/74	80	80	85
3.5.c	gear retraction	120	120	120	120	107	107	106	106	106
3,5.d	flap retraction	125	125	125	125	112	112	112	110	110
3.5.e	initial climb	100	100	100	101	91	96	105	105	100
3.5.f	cruise climb	120	120	120	110	105	105	130	120	120
5.1	Va/light	120	120	120	120	105	107/101	111	108	110
6.4	landing 50' agl	80	80	80	80	71	75	80	75	75
6.5.c	initial go-around	75	75	75	74	65	77	85	85	80
6.5.f	Vy clean	96	113	113	101	88	96	105	105	100
7.5	landing 50' agl	80	80	80	80	71	75	80	75	75
7.8	Vy/landing config.	75	75	75	74	65	68/71	75	85	80
7.11	takeoff 50'agl	80	80	80	80	71	75/74	80	80	85
7.13	Vy clean	96	113	113	101	88	96	105	105	100
8.7	takeoff 50' agl	80	80	80	80	71	75/74	80	80	85
9.1	Va/light	120	120	120	120	105	107/101	111	108	110
11.5.a	takeoff 50' agl	80	80	80	80	71	75	80	80	85
11.5.c	Vx/takeoff config.	70	70	70	70	66	68/77	75	85	75
11.5.e	Vy clean	96	113	113	101	88	96	105	105	100
11.7a.	landing 50' agl	80	80	80	80	71	75	80	75	75
11.7.c	short ldg 50' agl	70	67	74	71	65	69	75	70	70
11.7.e	max glide range	105	105	105	105	91	87	89	89	89
12.2.a	max glide rang	105	105	105	105	91	87/97	89	89	89
13.2.a	gear extension	120	120	120	120	132	132/140	140	140	140
13.2.b	flap extension	125	125	125	125	112	112	112	110	110
13.4.c	Vstall+5	70	75	75	70	68	68/70	70	71	70

Caution

The above speeds may be used as a quick general reference only. However, the pilot in command must consult the PILOT OPERATING HANDBOOK for the speeds recommended by Mooney Airplane Company for each operation.

NOTES

go around — full power
pitch up -
- positive rate of climb
Rid 1 knotch flaps -
Gear -
- if rid all flaps @ 65Kts - the aircraft will settle - sink

CHAPTER 3. AIRCRAFT PERFORMANCE

A Second Critical Area

This section considers another critical flight planning activity, the proper use of information contained in the aircraft performance charts. (It is assumed that our Mooney will be properly loaded, as discussed in Chapter 1.)

We all know that great feeling of flying the world's most efficient four place production aircraft. This section addresses methods which can help Mooney pilots optimize performance for a given mission, whether it be the annual Kerrville homecoming, proficiency training, or a Sunday morning $35 cup of coffee.

Planning precedes every flight and may range from a brief mental review of a familiar flight scenario to a lengthy session with Sectional/WAC/Low Altitude IFR charts, Instrument Approach Procedures, Pilot Operating Handbook (POH) performance and weight/balance data, weather briefing and flight plan filing.

The Pilot Operating Handbook (POH)

First a little background regarding the evolution of today's (1977 and later) Mooney POH. The 1960 Mark 20A OWNER'S MANUAL contains 28 pages, and devotes 4 pages to performance, normal and endurance cruise charts, and notes. An interesting feature of these charts is S/W (summer/winter) performance figures based on prevailing seasonal temperatures.

Takeoff and landing operations are described, but no quantitative data are included, nor is any weight and balance data or advice in the manual.

For weight and balance information, our intrepid M20A driver must refer to the AIRPLANE FLIGHT MANUAL (AFM) where he is told about gross weight and center of gravity limitations. WEIGHT and BALANCE DATA in the form of a loading schedule is contained in an insert to the AFM.

In the 1960s, the M20F OWNER'S MANUAL was issued with 96 pages, still with a separate loading schedule to be consulted for weight and balance data. In contrast, the current M20J POH comprises a total of 236 pages, organized into ten sections. The Performance section alone contains 38 pages, and the Weight and Balance section consists of 24 pages.

Mooney Owners Manuals and Pilot Operating Handbooks contain the following advice, which we would all do well to heed:

"...It is important that you - regardless of your previous experience - carefully read the handbook form cover to cover and review it frequently."

POH Performance Charts

POH performance data charts enable the pilot to derive information needed to plan flights with reasonable accuracy. These charts are calculated based upon actual flight tests, using average piloting techniques, the airplane and engine in good condition and the engine power control system properly adjusted.

Flight test data are corrected to international standard atmosphere conditions and then expanded analytically to cover various airplane gross weights, operating altitudes and outside air temperatures.

The charts make no allowances for varying levels of pilot technique, proficiency or environmental conditions. The effect of soft runways, winds aloft or airplane configuration changes must be evaluated by the pilot.

Generally, three items are required before entering each performance chart: (1) aircraft weight, (2) outside air temperature and (3) aircraft pressure altitude. The aircraft weight can be calculated utilizing the information provided in Section VI of current POHs and covered in Chapter 1 of these notes. Outside air temperature is obtained by reading the OAT gauge in the aircraft. Pressure altitude is obtained by setting the aircraft's altimeter to 29.92 inches Hg and reading the indicated value.

WARNING
BE SURE TO RESET THE ALTIMETER TO THE CURRENT LOCAL BAROMETRIC PRESSURE AFTER OBTAINING PRESSURE ALTITUDE.

Performance data on the charts can be duplicated by following the stated procedures in a properly maintained standard M20J. Performance derived by extrapolation beyond the chart limits is not valid for flight planning purposes.

Flight Planning Scenario (example)

In reviewing aircraft performance charts, we will plan a return flight in our M20J from Hypothetical Municipal Airport (HYP) to Hometown. Situated in Enigma County, HYP is infamous for its prevailing local conditions of wind, poor weather and density altitude, combined with unique runway characteristics. HYP is often used by ground school instructors for flight planning exercises.

NOTE

THIS SCENARIO IS FOR TRAINING AND ILLUSTRATIVE PURPOSES ONLY. THE "GO/NO-GO" DECISION, PERSONAL IFR MINIMUMS AND FUEL RESERVES, ACCEPTABLE CROSS WINDS, POWER SETTINGS AND FLIGHT PROCEDURES ARE PERSONAL DETERMINATIONS WHICH MUST BE CAREFULLY WEIGHED BY EACH PILOT BEFORE EVERY FLIGHT.

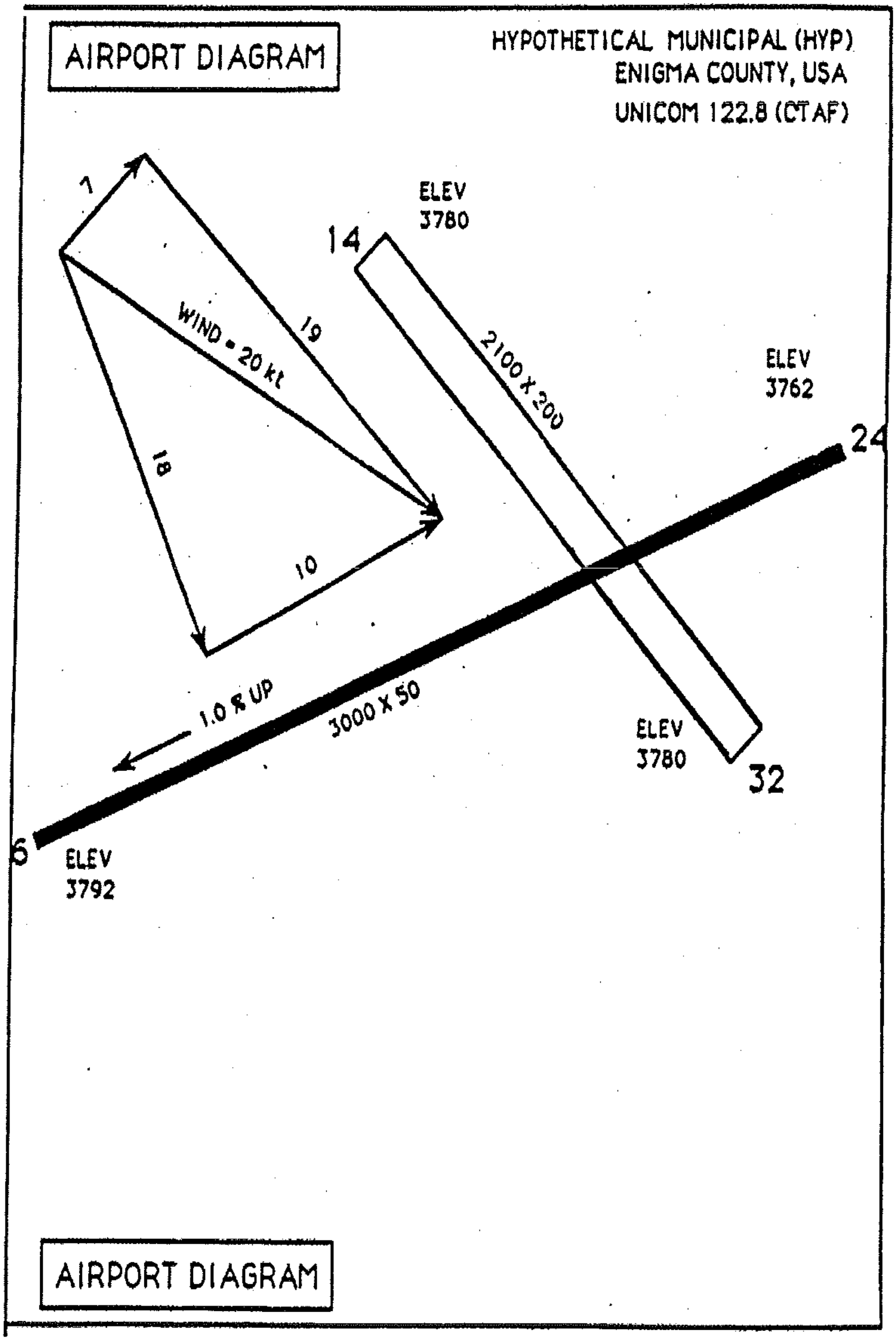
HYP, elevation 3792 ft, has a paved runway 6/24, 50 ft wide x 3000 ft long. It is 30 ft higher at the SW end than the NE. There are also trees at the SW end. Grass runway 14/32 is 200 ft wide x 2100 ft long, level surface. HYP has no Instrument Approach Procedure.

Our loading schedule calls for maximum gross weight (2740 lb), a useable fuel load of 32 gal/192 lb, and is within the center of gravity envelope. Current weather at HYP is ceiling indefinite (looks blue directly above), visibility 3 miles in haze. Wind is from 300 degrees at 20 kts. Air temperature is 89°F/32°C. Current altimeter gives a pressure altitude of 4000 ft. It rained last night.

Weather along the first 125 miles of our route of flight is marginal VFR to IFR due to fog and haze restricting visibility. Light to moderate turbulence across the mountains due to a SW wind 30-40 kt at 3000 agl. After the first 125 miles, en route weather is VFR. Tomorrow's forecast is for local VFR.

Takeoff Performance

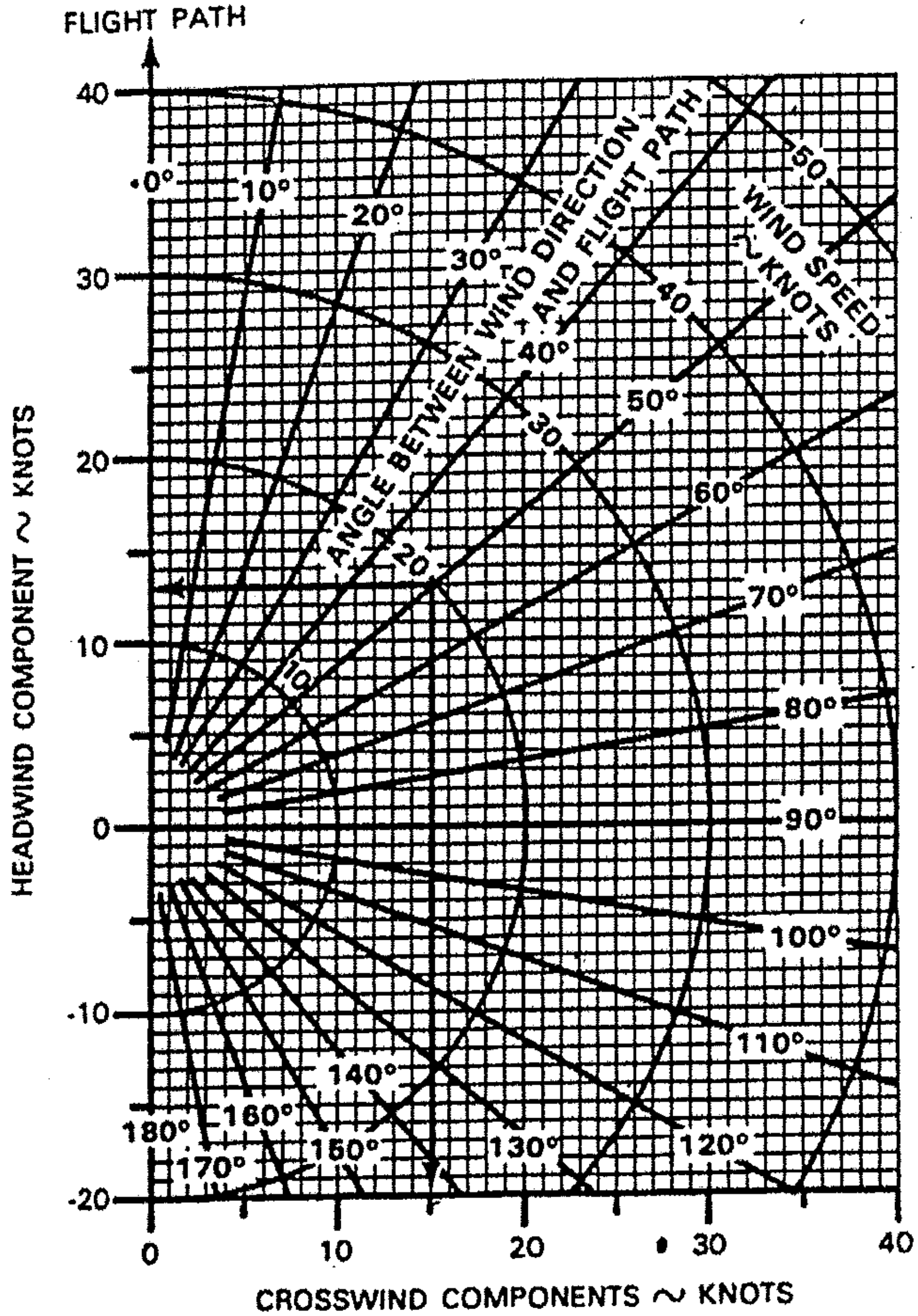
Knowing that the brisk wind will significantly affect our takeoff, we consider each of the 4 runways at HYP in turn. Referring to the airport diagram (page 3-4) and a wind component chart (page 3-5), we see that a downhill takeoff on runway 6 would encounter 10 kt tail wind and 18 kt cross wind components.


AIRPORT DIAGRAM
HYPOTHETICAL MUNICIPAL (HYP)
ENIGMA COUNTY, USA
UNICOM 122.8 (CTAF)
7
19
WIND = 20 kt
18
10
ELEV
3780
14
2100 X 200
ELEV
3762
24
1.0 % UP
3000 X 50
ELEV
3780
32
6
ELEV
3792
AIRPORT DIAGRAM

WIND COMPONENTS

EXAMPLE:

WIND SPEED	20 KTS
ANGLE BETWEEN WIND DIRECTION AND FLIGHT PATH	50°
HEADWIND COMPONENT	13 KTS
CROSSWIND COMPONENT	15 KTS



A look at the Normal Takeoff Distance Chart, page 3-7, shows that for our conditions (4000 ft/32°C, 2740 lb, 10 kt tail wind) and lifting off at exactly 63 kt, we would expect a runway 6 takeoff roll of 2000 ft. This leaves 1000 ft to spare, but we decide the 18 kt cross wind exceeds our personal minimums.

For a takeoff on runway 24 with a 10 kt head wind, the chart indicates a 1400 ft take off roll, much better, but we would have the 1% uphill grade to contend with and that same 18 kt cross wind. Using the Wind Component Chart for runway 14, we obtain a tail wind component of 19 kt, with only a 7 kt cross wind component.

NOTE

THE M20J MAXIMUM DEMONSTRATED CROSS WIND VELOCITY OF 11 kt IS NOT A LIMITATION, i.e. IT MAY BE LEGALLY EXCEEDED DURING TAKEOFFS AND LANDINGS.

For the takeoff roll we refer to the Maximum Performance Grass Runway Chart, page 3-8: nearly 4200 ft (much too long). However, runway 32 takeoff roll from the chart is only 1600 ft. Taking off into a 19 kt head wind rather than with a 19 kt tail wind gives a dry grass takeoff run over 2600 feet less.

Last night's rain presents another variable: the soft ground will lengthen our takeoff roll. Being realistic, we add 20% for "us instead of the factory plane and pilot" (320 ft), and 20% more for the soft ground, resulting in a total takeoff run of 2240 ft, from 2100 ft runway 32.

Our investigation of the four runways available at HYP has lead us to conclude that today "just isn't our day" and we opt for some sightseeing and tomorrow's VFR conditions.

Climb Performance

The next morning brings the forecast VFR with Northeast winds. There is some en route weather and we have filed IFR. The Rate of Climb Chart, page 3-9, gives a climb speed of 86 kias (2740 lb/4000 ft). To determine fuel requirements, we use the Time, Distance, and Fuel to Climb Chart, page 3-10. Finding the time, distance and fuel required to climb from the 4000 ft pressure altitude/32°C at HYP to our cruise altitude of 8000 ft/24°C (2°C/1000 ft lapse rate) takes 2 steps. First determine the climb values to 4000 ft and then subtract them from the 8000 ft values.

NORMAL TAKEOFF DISTANCE

TAKEOFF WEIGHT - LBS (KGS)	LIFTOFF SPEED - KIAS	SPEED AT 50 FT - KIAS
2900 (1315)	59	76
2600 (1180)	58	76
2300 (1043)	55	71

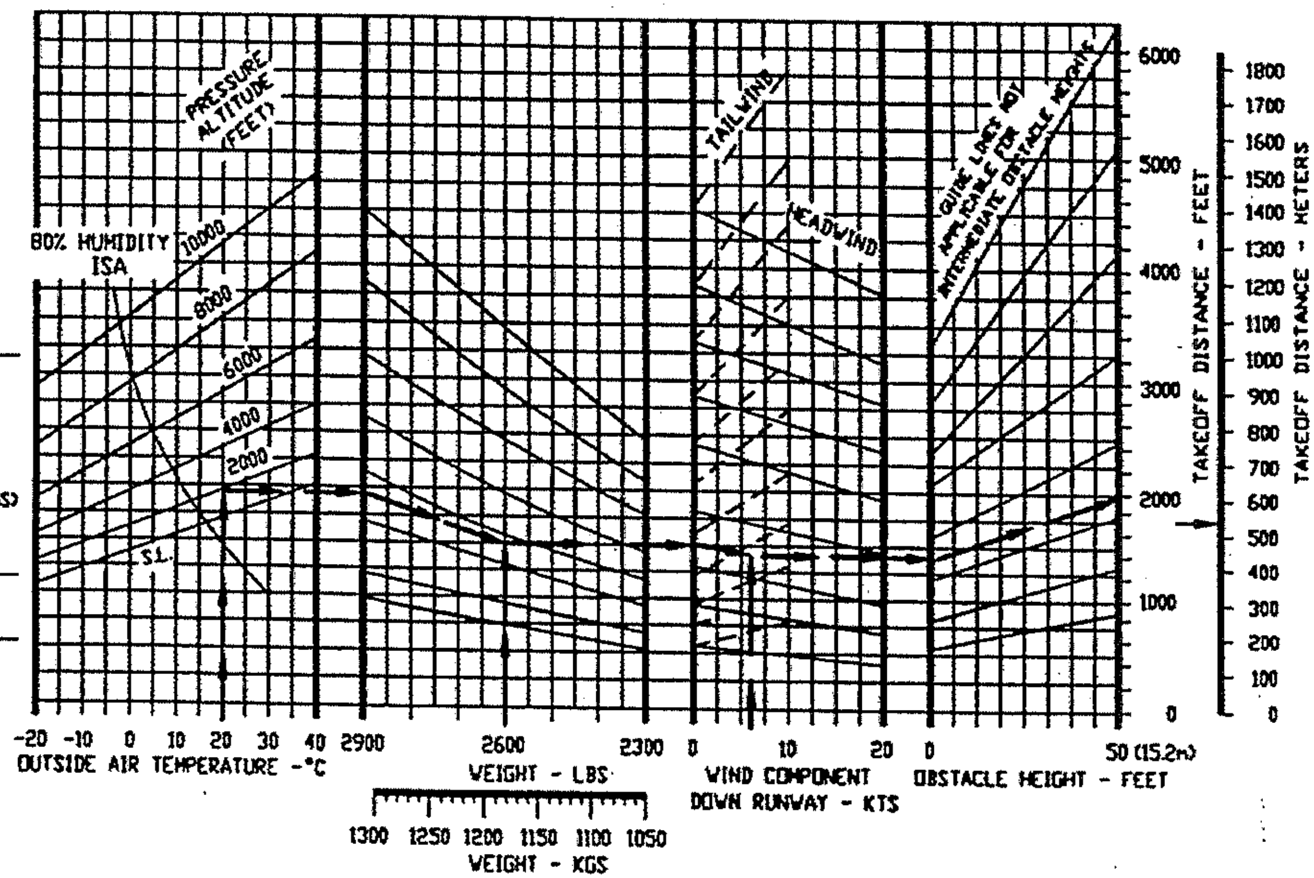
NOTE
1) MAXIMUM DEMONSTRATED CROSSWIND VELOCITY IS 11 KNOTS
2) SET FULL POWER PRIOR TO BRAKE RELEASE.
3) TO OBTAIN THE SPEED AT 50 FT. INCREASE PITCH ATTITUDE APPROX. 5° AFTER LIFTOFF.

ASSOCIATED CONDITIONS

POWER	FULL THROTTLE, 2700 RPM, 80% HUMIDITY
LANDING GEAR	EXTENDED UNTIL OBSTACLE CLEARED
WING FLAPS	15°
COWL FLAPS	FULL OPEN
RUNWAY SURFACE	PAVED, LEVEL & DRY

EXAMPLE: ⟶

OAT	20°C
PRESSURE ALTITUDE	2000 FT.
WEIGHT	2600 LBS. (1180 KGS)
HEADWIND COMPONENT	6 KTS
GROUND ROLL	**1390 FT (424 M)**
TOTAL TAKEOFF DISTANCE (50 FT. OBSTACLE)	2000 FT. (610 m)



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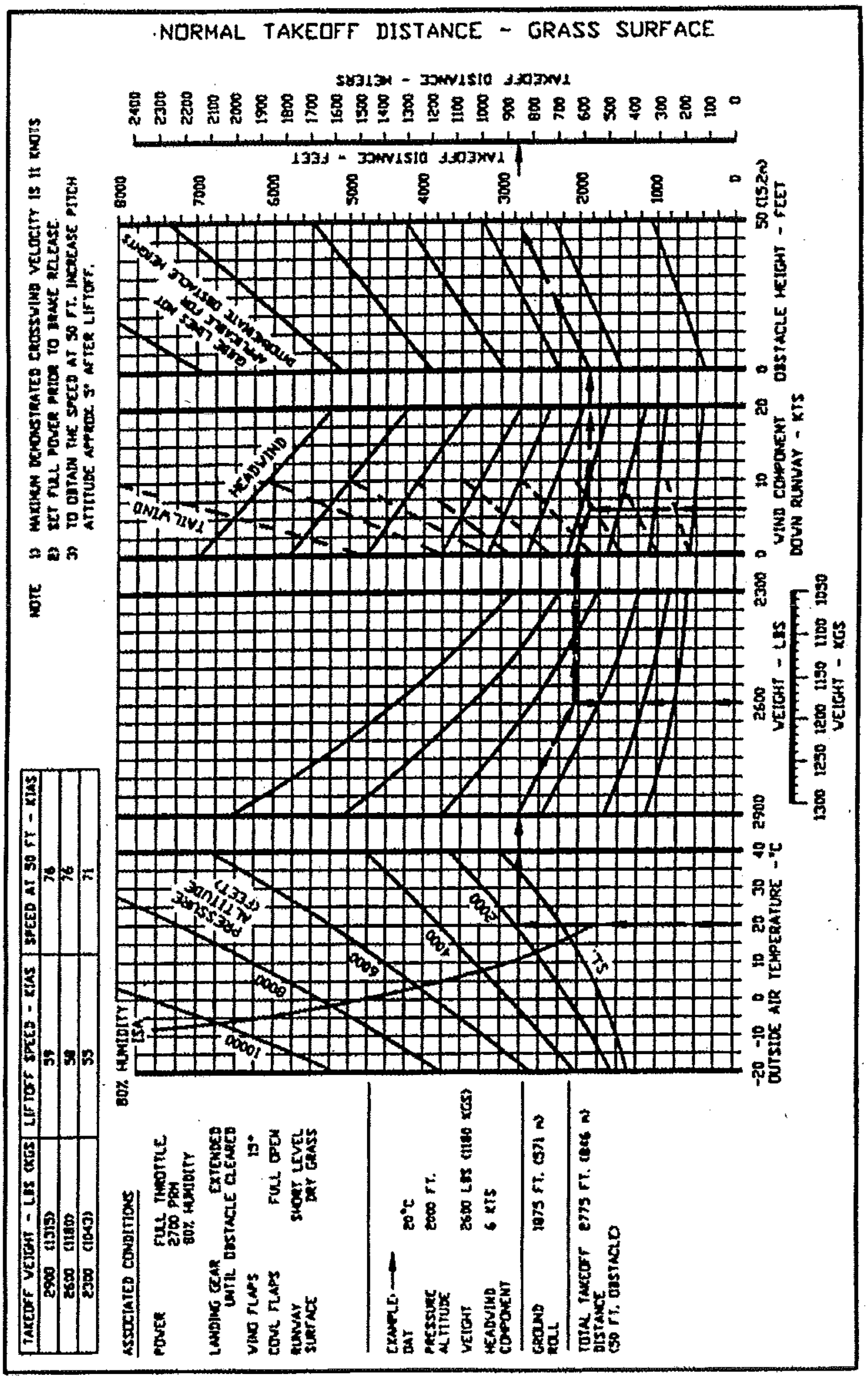

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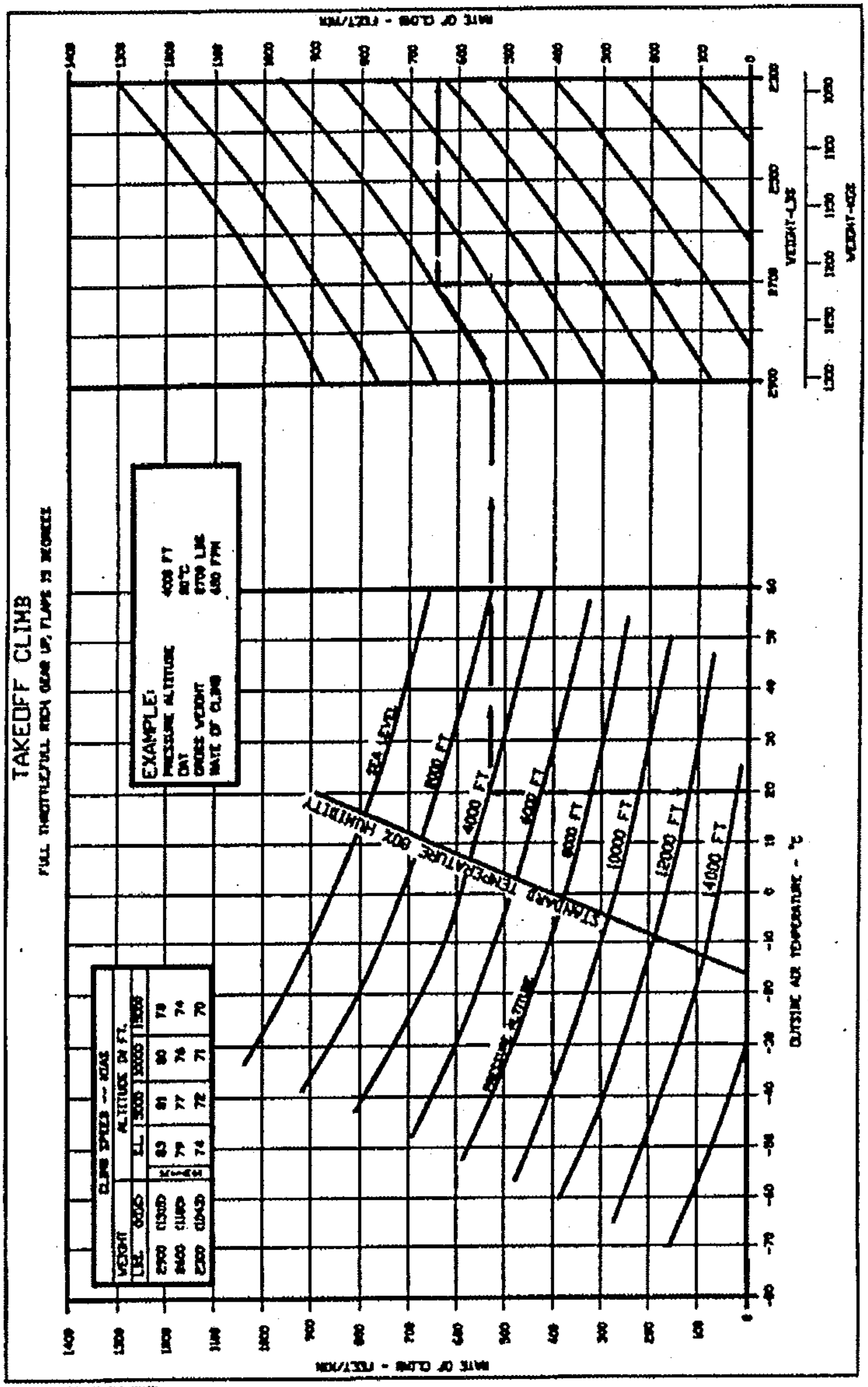

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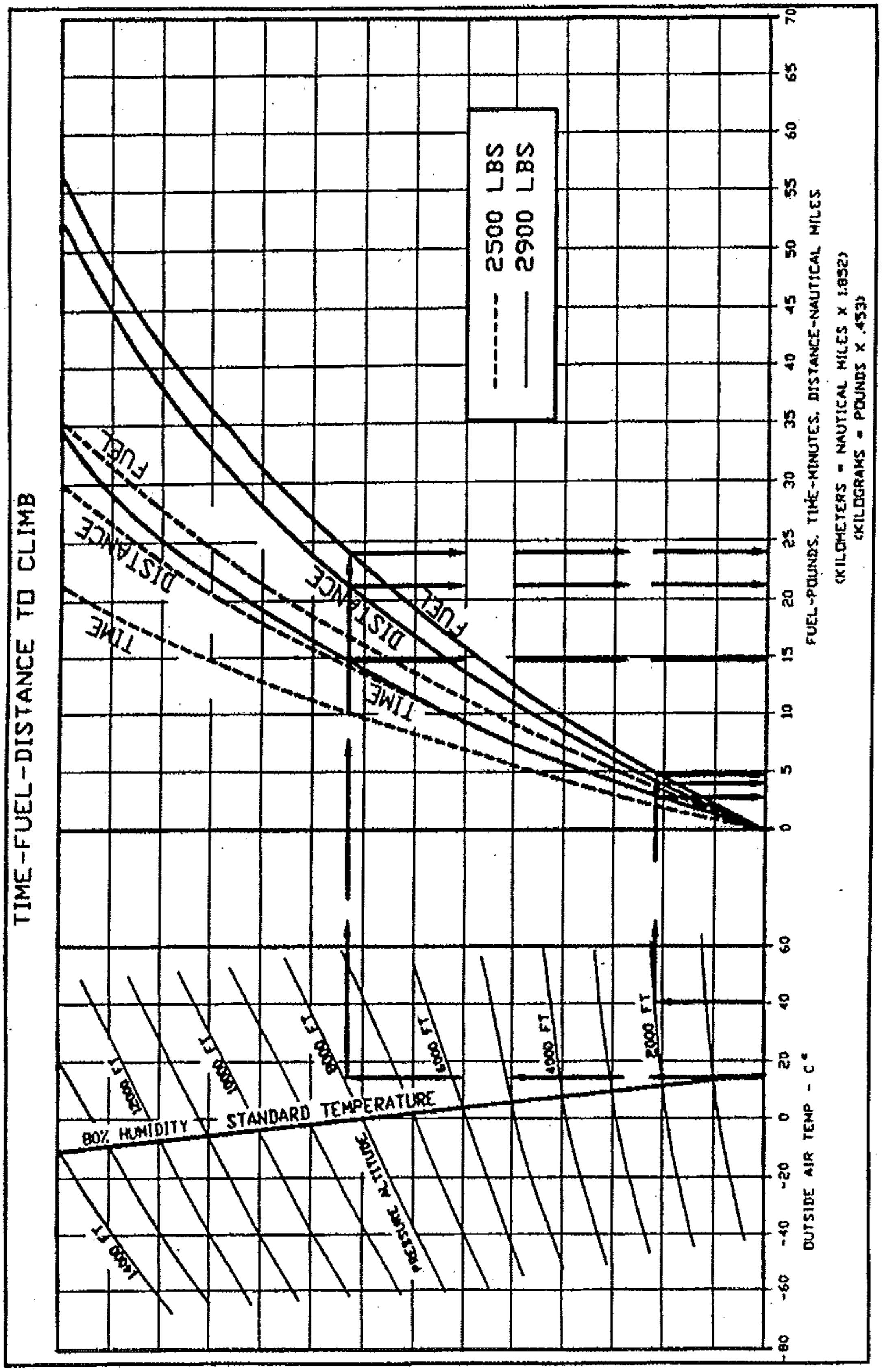
TIME, FUEL & DISTANCE TO CLIMB



This information is tabulated below:

	Time	Distance	Fuel
Climb to 8000 ft/24°C:	14 min	22 nm	4.0 gal
Climb to 4000 ft/32°C:	8 min	12 nm	2.1 gal
Climb 4000 ft to 8000 ft:	6 min	10 nm	1.9 gal

Adding 1.5 gal for start/taxi/run up/takeoff gives a total of 3.4 gal used before beginning the en route phase. Our 32 gal usable fuel load at start up minus the 3.4 gal used leaves us 28.6 gal for cruise, descent, and IFR reserves.

Cruise Performance

At 65% economy cruise power at 8000 ft and 2740 lb we will burn 9.4 gph. Using 2600 rpm, we determine correct manifold pressure by adding 1.0" for the 25°C above standard day temperature. (Cruise Power Schedule Chart, page 3-12).

True air speed will be 164 kt. (Speed Power vs Altitude Chart, page 3-13).

We report reaching 8000 ft, and determine our actual ground speed en route by using DME, Loran, or Flight Computer, to update our reserve fuel estimate. Encountering headwinds, we find that our actual ground speed is 140 kt.

Now for the single most important calculation - - - confirmation that we have enough fuel remaining to reach Hometown. Remember that our engine "knows" only how long it has been running, not how far it has flown. We must use time, not distance to update actual fuel status. At a fuel burn rate of 9.4 gph, the 28.6 gal we have on board will run the engine for 3.0 hr (28.6 / 9.4 = 3.04). Our required IFR reserve is 1.2 hr, leaving 1.8 hr for the en route segment. (POH Range and Endurance charts assume full fuel and do not apply to our situation.)

The distance remaining to Hometown is 210 nm and estimated time en route at our 140 kt ground speed is 210 / 140 = 1.5 hr, well within our remaining en route fuel endurance of 1.8 hr.

Mooney M20 J

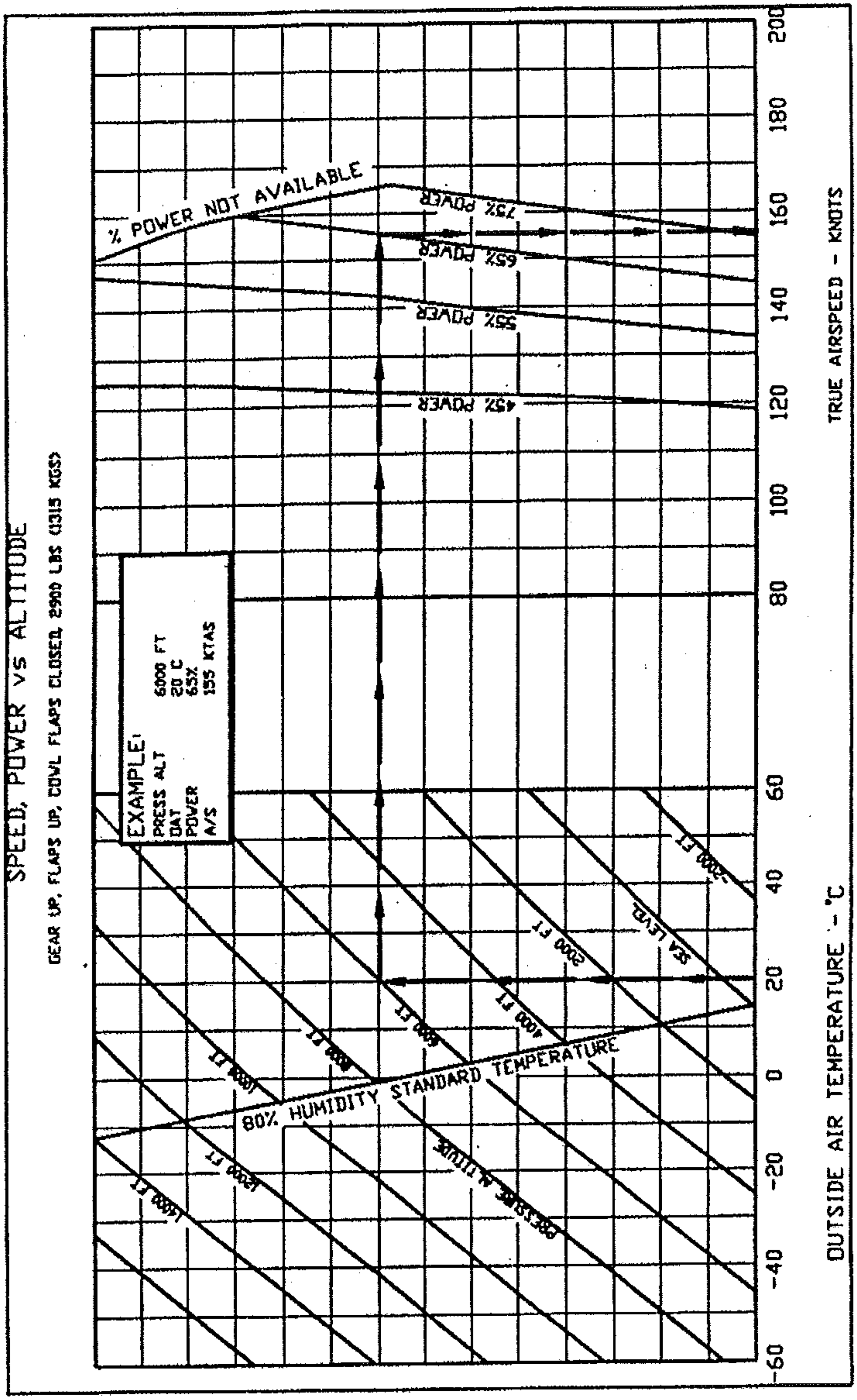
CRUISE POWER SCHEDULE

EXAMPLE:
CRUISE ALT. 6000 FT.
OAT 10°C(50°F)
POWER 65%
RPM 2600
M.P. 22.0
(7° C CORRECTION)

1. BEST POWER IS 55°C(100°F) RICH OF PEAK EGT.
2. ECONOMY CRUISE IS 14°C(25°F) RICH OF PEAK EGT.

NOTE: ADD .4" M.P. FOR EACH 10°C(18°F) OAT ABOVE STANDARD DAY TEMPERATURE. SUBTRACT .4" M.P. FOR EACH 10°C (18°F) BELOW STD. DAY TEMPERATURE. IF OAT ABOVE STANDARD PRECLUDES OBTAINING THE DESIRED M.P. USE THE NEXT HIGHER RPM/ M.P. WITH APPROPRIATE TEMPERATURE CORRECTION TO M.P.

Pressure Altitude Feet Std. Day		75% Power (150 BHP)				70% Power (140 BHP)				65% Power (130 BHP)			
	RPM	2400	2500	2600	2700	2400	2500	2600	2700	2400	2500	2600	2700
Fuel Flow	Best ECON.	10.3	10.4	10.5	10.8	9.7	9.8	9.9	10.2	9.2	9.3	9.4	9.6
Fuel Flow	Best POWER	12.0	12.2	12.3	12.5	11.3	11.5	11.7	11.9	10.5	10.8	11.0	11.2
	Std. Temp.	MANIFOLD PRESSURE — INCHES OF MERCURY											
S.L.	15°C	27.0	25.8	24.5	23.5	25.5	24.3	23.0	22.0	24.0	22.9	21.7	21.0
2000	11°C	26.8	25.6	24.4	23.3	25.1	24.1	23.0	22.0	23.6	22.6	21.6	20.6
4000	7°C			24.4	23.2	24.9	23.9	22.9	21.8	23.3	22.4	21.5	20.5
6000	3°C			24.1	23.1	24.4	23.6	22.7	21.7	22.8	22.1	21.3	20.4
8000	−1°C				23.6			22.7	21.7			21.2	20.4
10000	−5°C								21.4			21.1	20.2
12000	−9°C												
14000	−13°C												


SPEED, POWER VS ALTITUDE
GEAR UP, FLAPS UP, COWL FLAPS CLOSED, 2900 LBS (1315 KGS)
EXAMPLE:
PRESS ALT 6000 FT
OAT 20 C
POWER 65%
A/S 155 KTAS
% POWER NOT AVAILABLE
75% POWER
65% POWER
55% POWER
45% POWER
80% HUMIDITY STANDARD TEMPERATURE
PRESSURE ALTITUDE
14000 FT
12000 FT
10000 FT
8000 FT
6000 FT
4000 FT
2000 FT
SEA LEVEL
-2000 FT
TRUE AIRSPEED - KNOTS
80
100
120
140
160
180
200
OUTSIDE AIR TEMPERATURE - °C
-60
-40
-20
0
20
40
60

Descent Performance

When we are forty miles out from Hometown, the Center Controller clears us to descend to 3000 ft before crossing an intersection 20 miles ahead. Using the Time, Distance, and Fuel to Descend Chart, page 3-15, we obtain the following information (required time, distance, and fuel all have a direct linear relation to the required altitude loss):

	Time	Distance	Fuel
Descent from 8000 ft :	11 min	29 nm	1.1 gal
Descent from 3000 ft :	4 min	11 nm	0.4 gal
Descend 8000 to 3000 ft:	7 min	18 nm	0.7 gal

Note that the associated conditions from the descent chart include 2400 rpm, and mp as required to maintain a 750 fpm rate of descent.

To attain the POH value for fuel burn during descent, we must lean to 14°C/25°F rich of peak exhaust gas temperature (EGT). Leaning has the added benefit of reduced spark plug fouling. If leaning during descent is not discussed in your POH or Owners Manual, information may be found in the Engine Operator's Manual.

In general during any descent we wish to avoid unnecessary engine cooling while taking full advantage of the reduced fuel burn available. We avoid shock cooling the engine by decreasing propeller speed to the lowest allowable cruise rpm and making several gradual reductions in manifold pressure.

Some M20s have rpm ranges within which continuous operation must be avoided, but the general technique of descending with low rpm/moderate mp rather than higher rpm/lower mp, will help eliminate piston ring flutter and maintain higher cylinder head temperatures.

Landing Performance

We have encountered blue skies and are now talking to a familiar Hometown Approach controller. We cancel our IFR flight plan and remain on the approach frequency for our flight into Hometown Class "C" airport. Ten miles out Hometown tower clears for a left base entry to land on runway 7, "number two behind a Bonanza."

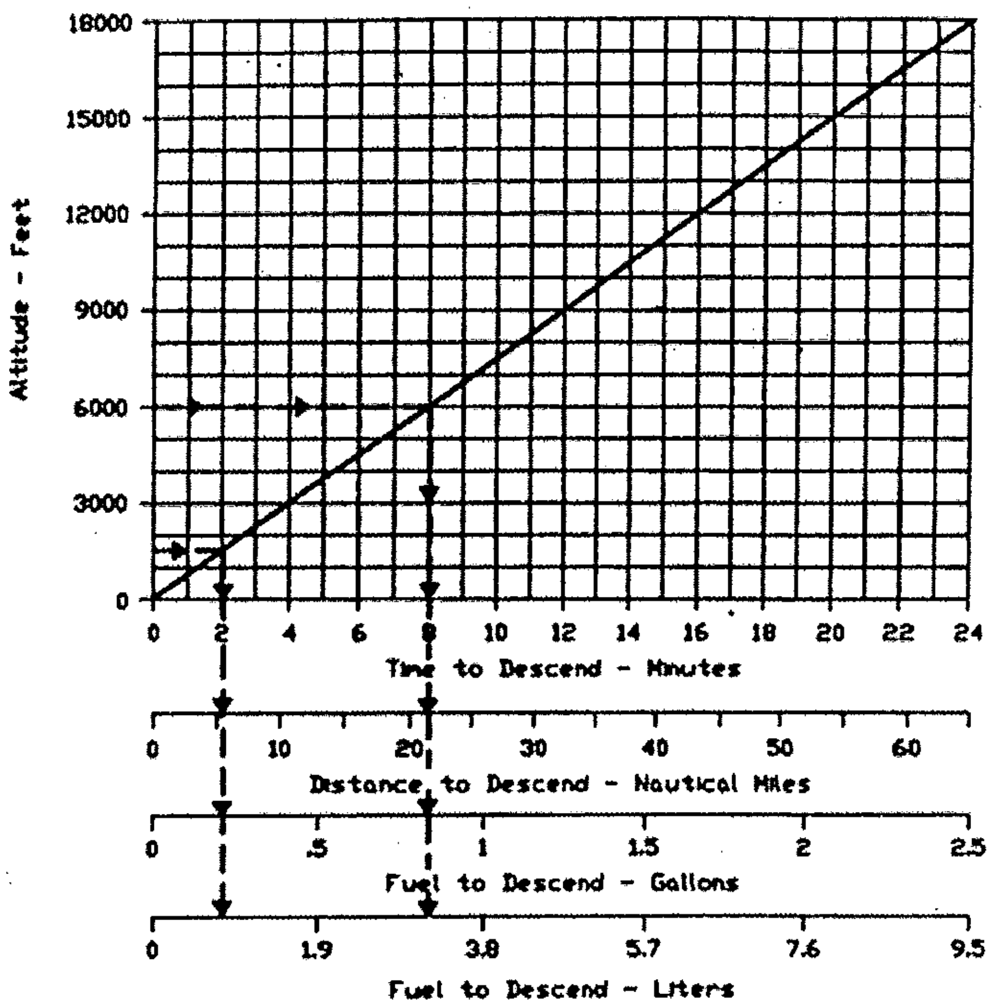
TIME - FUEL - DISTANCE TO DESCEND
150 KIAS DESCENT SPEED

EXAMPLE:

Initial Pressure Alt.....6000 Ft.
Final Pressure Alt.....1500 Ft.
Fuel to Descend .....0.8 - 0.2 =0.6 Gals.
3.0 - .76 =2.24 Liters
Time to Descend .....8.0 - 2.0 = 6.0 Mins.
Distance to Descend...21.0 - 5.0 = 16.0 NM

ASSOCIATED CONDITIONS:

Power : 2400 RPM-MAP as required maintain 750 FPM rate of Descent.
Landing Gear: UP
Flaps: UP
Cowl Flaps: UP
Mixture: 14°C Rich of Peak.



On a one mile final, we are surprised to see the Bonanza ahead motionless on the runway near the crosswind runway intersection as the tower instructs "Mooney 87U, Go Around!" While executing the go-around, we can see the Bonanza passengers deplaning with only a short step to the ground.

Hometown Tower advises that the field will be closed for at least 1 hour, almost all of the fuel we have on board.

We decide to "drop in" on friends who live at a nearby fly-in community. strip. The 3000 ft runway, elevation 2001, has clear approaches and the headwind component is 6 kts.

Referring to the Normal Landing Distance Chart, page 3-17, for our present weight of 2600 lb and outside air temperature of 20°C, we obtain the recommended approach speed of 74 kias, and a ground roll of 975 ft, with the use of Maximum braking.

Mooney Aircraft Pilots Association Safety Foundation

NORMAL LANDING DISTANCE

LANDING WEIGHT - LBS (KGS)	APPROACH SPEED KIAS
2900 (1315)	78
2600 (1180)	74
2300 (1043)	70

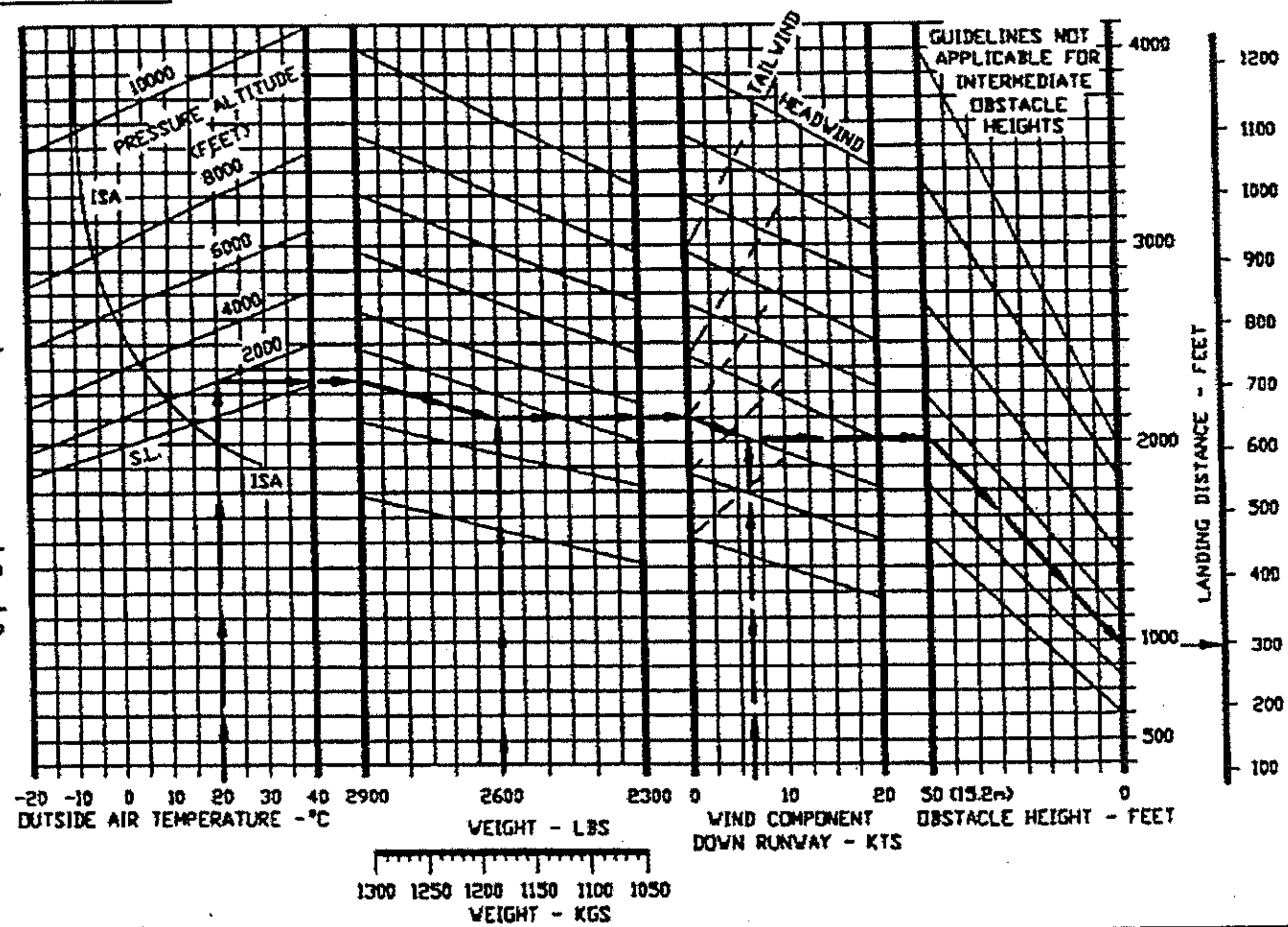
NOTE: 1) MAXIMUM DEMONSTRATED CROSSWIND VELOCITY IS 11 KNOTS
2) AFT CONTROL WHEEL PRESSURE IS RECOMMENDED TO IMPROVE BRAKING EFFECTIVENESS DURING LANDING ROLL.

ASSOCIATED CONDITIONS

POWER	IDLE
LANDING GEAR	DOWN
WING FLAPS	FULL DOWN (33°)
RUNWAY SURFACE	PAVED, LEVEL & DRY
BRAKING	MAXIMUM

EXAMPLE: ——►

OAT	20°C
PRESSURE ALTITUDE	2000 FT.
WEIGHT	2600 LBS (1180 KGS)
HEADWIND COMPONENT	6 KTS
GROUND ROLL	975 FT. (297 m)
TOTAL LANDING DISTANCE (50 FT. OBSTACLE)	2005 FT. (611 m)



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MOONEY PILOT PROFICIENCY PROGRAM
NOTES TO PRE-CLASS WORKSHEET

The real purpose of your pre-class assignment was to have each student get out his aircraft Pilot's Operating Handbook (POH) or Owner's Manual and dust off a few cobwebs while completing the worksheet. Congratulations to those who thought some of the questions were ambiguous or incompletely defined. We hope these notes will give additional insights and points to consider during your future flight planning. Please complete the worksheet before reading on.

1. AIRCRAFT DATA

1.1 **Maximum Gross Weight** - Easy, but remember **maximum allowable weight** must be reduced at forward CG locations.

1.2 **Empty Weight** - Another easy one, but remember to use the value for **YOUR AIRPLANE,** not the standard empty weight from the sample CG example. Also, its the pilot's responsibility to see that the **CURRENT Form 337** is in the plane.

1.3 **Useful Load** - An easy subtraction.

1.4 **Useable Fuel (lbs)** - Did you know 100LL weighs 5.82 lb/gal?

1.5 **Payload (full fuel)** - Another easy subtraction.

1.6 **Electrical System Voltage** - More than one panel full of 12 volt avionics has been destroyed by 24 volt ground power!

1.7 **Nose and Main Tire Pressures** - How often do you check these?

1.9 **Brake Reservoir Location** - When was the last time you checked the hydraulic fluid and battery acid levels?

1.10 **Propeller Clearance** - Remember this when taxiing on gravel.

2. AIRSPEEDS

2.1 **Maneuvering Speed (gross wt)** - Remember that this **speed must be reduced** as fuel is burned off and **weight decreases.**

2.2 **Maximum Gear Retraction Speed** - Remember that this speed is less than the allowable flying speed after the gear is down, or the speed at which the gear may be extended.

2.3 **Maximum Flap Extended** - Is this true or indicated air speed?

2.4 **Stall Speed, Landing Configuration** - The bottom of the white arc defines the stalling speed at gross weight and most forward CG in landing configuration. This **speed decreases** as fuel is burned off, and as the CG moves aft.

2.5 **Stall Speed, Gear and Flaps Up, 30°Bank** - In level flight, stall speed increases whenever the wings are not horizontal.

2.6 **Best Angle of Climb Speed** - How does this IAS change as altitude increases?

2.7 **Final Approach Speed** - How does this IAS change as weight decreases?

2.8 **Aborted VFR Landing** - Airspeed control is the most important flight management task during a Go-around. Don't waste time and altitude by accelerating to a higher speed.

3. **PERFORMANCE**

3.1 Fuel Burn & Speed @65%, S.L. Is fuel burn at 65% power, best economy, different at S.L. and 10000 ft? What does your manual say about leaning at 65% power?

3.2 Fuel Burn & Speed @65%, 10000 ft. Is true airspeed, at the same 65% power, different at S.L. and 10000 ft? Indicated airspeed?

3.3 Take Off Roll, Gross Wt, 6000 Elev, Standard Temp. How does this compare with T.O roll at Sea Level?

3.4 Clear 50 ft obstacle, for above T.O. situation. How does this compare with distance to clear 50 ft obstacle at S.L?

4. **WEIGHT and BALANCE** There will be a general classroom discussion of Weight and Balance calculations.

MOONEY PILOT PROFICIENCY PROGRAM
STUDENT PRE-CLASS WORKSHEET No. 1

PILOT________________________________ A/C MODEL/YR__________/__________
PILOT OPERATING HANDBOOK (POH) REVISION DATE_____________________

NOTE: Be sure to bring your Pilot's Operating Handbook or Owner's Manual with Weight and Balance supplement, and any other documents, which are relevant to the flight planning or operation of your Mooney.

Please complete the following **before** the MPPP ground school and bring to class with you. Questions regarding this worksheet are welcome during the MPPP.

1. AIRCRAFT DATA

1.1 Maximum Gross Wt.______

1.2 Empty Weight ______

1.3 Useful Load ______

1.4 Useable Fuel,lbs ______

1.5 Payload,full fuel ______

1.6 Electrical Sys Voltage ______

1.7 Nose Tire Pressure ______

1.8 Main Tire Pressure ______

1.9 Brake Reservoir Loc. ______

1.10 Propeller Clearance ______

2. AIRSPEEDS (circle mph or kt)

2.1 Maneuvering (gross wt) _______mph/kt

2.2 Maximum Gear Retraction _______mph/kt

2.3 Maximum Flap Extended _______mph/kt

2.4 Stall, Landing Config. _______mph/kt

2.5 Stall, Clean, 30°Bank _______mph/kt

2.6 Best Angle of Climb _______mph/kt

2.7 Final Approach Speed _______mph/kt

2.8 Aborted VFR Landing _______mph/kt

MOONEY PILOT PROFICIENCY PROGRAM
STUDENT PRE-CLASS WORKSHEET No. 1 (continued)

3. PERFORMANCE

3.1 Fuel Burn & Speed @65%, S.L. _____gph _____mph/kt

3.2 Fuel Burn & Speed @65%, 10000_____gph _____mph/kt

3.3 T/O. Roll, Gross Wt, 6000 Elev, Standard Temp. ______ft

3.4 Clear 50 Ft Obstacle, for above T.O. situation ______ft

3.5 Manual page references for 3.1, 3.2, 3.3, and 3.4 above

4. WEIGHT and BALANCE

4.1 Maximum fuel load, lbs, with:
pilot and copilot at 180 lb each
2 passengers at 120 lb each
baggage at 120 lb

4.2 C.G. location for loading in 4.1:

4.3 Range for loading in 4.1, VFR flight with reserves:

4.4 Range for loading in 4.1, IFR flight with reserves:

4.5 Maximum baggage with 180 lb pilot, no passengers, full fuel:

4.6 Location of baggage carried for loading in 4.5 above:

NOTES

Loading and Unloading Passengers

This section, taken directly from the 1959 Mooney Mark 20A Owner's Manual, is included in part for nostalgia, but primarily because we have never seen a better discussion of the topic.

For easiest loading of passengers, use the following procedures. With both front seats all the way to the rear, the pilot should climb into the left front seat first. Placing his right hand on the steel cross-bar under the instrument panel and his left hand on the seat adjustment lever beneath the left front seat, he should slide the seat forward to a comfortable position.

NOTE: The further forward the pilot sits, the better his visibility will be over the nose and the leading edge of the wing.

When the pilot is comfortably seated with his seat properly adjusted, he should then slide the right front seat all the way forward and allow his two rear-seat passengers to enter.

After they are seated, the pilot should slide the right front seat back to the last notch and, while holding the control wheel full forward, allow his front-seat passenger to enter. When this passenger is seated, he should slide the right front seat forward to a comfortable position.

To close the door, grasp the door-pull strap and press the door in tightly against the seal.

NOTE: Do not slam the door, slamming the door is likely to damage the latching mechanism and put the door out of adjustment.

Holding the door tight against the seal, rotate the door handle full forward until the latch locks into position.

For best results in unloading your passengers, use the following sequence:

1. Unload the right front seat by sliding the seat back to the last notch and allowing your right front seat passenger to step out. Hold the control wheel forward to give him more room.

2. Now slide the right front seat all the way forward and allow the two rear passengers to disembark.

3. Then slide both front seats all the way back and, placing your right hand on the back of the right front seat and placing you right foot on the right front cabin floor, step toward the door and out of the cabin.

4. Close the door and latch it.

The Thumbnail Check (Manual Gear Operation)

Mooneys built through 1969 had manual gear retraction systems as standard, and experienced Mooney pilots take justifiable pride in their operation of this proven equipment. Unfortunately, there are all too frequent instances of manual gear inadvertent retractions. Here we describe some techniques which may help the new "Johnson Bar" operator to avoid such an embarrassing and expensive event.

The gear down-and-locked condition is assured by locking the "Johnson Bar" landing gear actuator in the vertical position with a machined metal "keeper" which is spring loaded to the locked position. Conversely, when the "Johnson Bar" is locked down between the seats, the gear is fully retracted.

To retract the gear the lock button is pressed with the right thumb, the gear handle grip is rotated slightly to help break friction, and a simultaneous downward force is applied to the gear handle, moving it aft and out of the keeper. The landing gear must be retracted before reaching $V_{lo(ret)}$, which is 104 kt for all M20s. Retraction is easiest at lower speeds, and should be accomplished as soon as the gear is no longer useful for a straight-ahead landing.

Some Basics

It is easy to get into dangerous and boring ruts as far as our flying goes. We hope the material in this chapter will encourage the pilot to experiment intelligently with different power settings, particularly at lower altitudes and during descents. Proper manifold pressure, propeller speed and mixture management techniques, as approved by airframe and engine manufacturers, can bring real benefits in lowered fuel consumption, longer engine life, and reduced noise and fatigue levels.

Do not hesitate to lean your engine during ground operations, when you are sure to be using much less than 75% power. Most carbureted and fuel injected engines tend to run so rich that, without leaning, spark plug fouling is inevitable during a long taxi or while awaiting takeoff clearance. Magneto and engine run ups must be performed per the POH, normally at full rich. Remember also, the takeoff check must include enriching, except for high altitude airport operations with non-turbocharged equipment.

When operating in or near Class B,C or D, airspace have a departure plan which includes the first heading and altitude, and a subsequent climb profile.

Try climbing faster with cowl flaps closed or only partially open. This comes straight from the man who should know, Roy Lopresti! Roy says many of the newer 201s and 205s will maintain cylinder head temperatures well in the green with cowl flaps only half open, and fly up to 4 knots faster with the same rate of climb.

NOTE

CLOSE MONITORING OF ENGINE TEMPERATURES IS MANDATORY FOR UNEXPECTEDLY WARM CONDITIONS, TEMPERATURE INVERSIONS, etc, WHICH MAY DICTATE USE OF FULL OPEN COWL FLAPS DURING CLIMB.

Power Management Myths

There are two popularly held beliefs that are not valid with most current internal combustion engines. The first encourages routine use of 23 in manifold pressure and 2,300 rpm, a procedure commonly called "23 square." Such a power setting can surely be used, but the pilot may not be using all available power setting information. At lower altitudes, there is a variety of recommended MP and rpm settings, and a pilot should use the one appropriate to his mission for best aircraft performance. (See "Key Number" discussion below.)

The second myth claims that manifold pressure in inches Hg should never exceed rpm in hundreds. When using 2400 rpm, for example, this myth says that MP should not be greater than 24 in. Such a technique might be justified for early engine designs, but has no place in "modern" power plant operations.

In fact, this "rule of thumb" is violated during every low elevation takeoff where manifold pressure is close to 30 inches and rpm is as much as "five" less (or even more in the case of geared engines.) A pilot may use any combination of MP and rpm specified in the power charts for his engine.

When operating the M20J 200 HP Lycoming IO-360-A3B6D (or A1B6D) at 75% rated power, for example, we can use extremes of 2700 rpm and 23 in MP, 2300 rpm and 27 in MP, or any of several in-between combinations.

There are however, other considerations, such as the higher pressures created within the cylinders. Even though the Mooney POH's generally allow cruise at a lower RPM with higher manifold pressure, Teledyne Continental recommends using an RPM in the mid ranges (2350-2500), provided that the engine runs smoothly at the selected RPM. Lycoming does not specifically address the issue of RPM/MP selection, but does leave it to the POH and the pilot.

There is a theory that at lower RPM and higher MP you will be "lugging" your engine. Conversely, at a higher RPM and lower MP your engine will be turning more cycles, but they are easier cycles with less internal pressure.

The over riding consideration should be a smooth running engine at whatever authorized combination of RPM/Mp you select. When researching this topic be sure to refer to the more complete information in the engine operating manual as well as your POH.

The Key Number

Frequently we may want to set MP and rpm to develop a certain percent of rated horsepower. For normally aspirated engines, the "key number" approach provides an easy means without having to refer to power tables. Simply stated, for "green arc" rpm ranges, add the rpm in hundreds to the MP to arrive at our key number. For example, "23 square" gives a key number of "46".

For moderate altitudes (2,000-10,000 MSL) the M20J key numbers are "50" for 75% of rated power, "47" for 65%, and "44" for 55% power. For the M20F, the key numbers are "48" for 74% of rated power, "45" for 64%, and "42" for 55%.

The "key number" is a handy way to determine equivalent power settings. Given a set of MP and rpm values, calculate the "key number"; then develop alternative combinations of MP and rpm having the same "key number" and hence the same power.

The following table gives various M20F and M20J MP and rpm settings for common power levels. This method is accurate to about 3%, or about as good as the power tables when corrections for temperature and humidity are not made.

QUICK POWER SETTINGS-20F			
RPM	74%	64%	55%
2600	22"	19"	16"
2500	23"	20"	17"
2400	24"	21"	18"
2350	24.5"	21.5"	18.5"
KEY #	**48**	**45**	**42**

QUICK POWER SETTINGS-M20J			
RPM	75%	65%	55%
2600	24"	21"	18"
2500	25"	22"	19"
2400	26"	23"	20"
2300	27"	24"	21"
2200	-	25"	22"
KEY #	**50**	**47**	**44**

Density Altitude

Much of the Information in this section was obtained from AVEMCO Flying Safety Update 90, Density Altitude: Living by the Numbers).

Every pilot should understand the inescapable influence of density altitude on aircraft and engine performance, particularly as is applies to his flight operations. Hot, high, and humid weather can change a routine takeoff or landing into an accident literally within seconds.

There are three important factors that affect air density:

1. **Altitude** - The higher the altitude, the less dense the air.

2. **Temperature** - The warmer the air, the less dense it is.

3. **Humidity** - Humidity is not generally considered a major factor in density altitude computation, because the effect of humidity is related to engine power rather than aerodynamic efficiency.

When the temperatures rise above standard, the density of the air is **reduced**, but density altitude **increases**. This affects the aircraft's aerodynamic performance and decreases the horsepower output of the normally aspirated engine, often raising the apparent altitude of an airport by thousands of feet.

Although high density altitude and high humidity do not often go hand-in-hand, if high humidity does exist the FAA has said to add a 10% safety margin to computed takeoff distance and to anticipate a reduced rate of climb.

The POH provides aircraft performance information for standard atmospheric conditions (59°F/15°C, and 29.92 inches of mercury at sea level.) Charts are also provided for converting standard-day performance to the actual conditions at flight time.

Takeoff and climb phases, and go-arounds, have been identified as those most vulnerable to the effects of density altitude. Pilots must also consider the fact that their higher time aircraft may be less efficient than when it left the factory. Dirty air filters, worn ducts, and under-inflated tires are among the items for which periodic inspection and maintenance are necessary.

While the effects of density altitude are increasingly dramatic at higher elevations, they are not confined to mountainous areas. Even at lower elevations aircraft performance can become marginal and it may be necessary to reduce gross weight for safe operations.

Takeoff distance, available power (in normally aspirated engines) and climb rate are each adversely affected by the effects of density altitude. Even with turbocharged engines, reductions in propeller thrust and lift from the wing will be encountered at high altitudes or high-density altitudes.

When maximum power available is less than 75%, or at density altitudes above 5000 feet, POH recommendations for leaning normally aspirated engines should be followed. Turbocharged engines do not require leaning for takeoff in high-density altitude conditions as they can produce manifold pressures equal to or higher than those at sea level. Again, consult the POH for specific recommendations.

At higher elevation airports, high temperatures sometimes have such an effect on density altitude that safe operations between mid-morning and mid-afternoon can be extremely hazardous, or even impossible for many aircraft. When performance is in question, flights should be scheduled during the cooler hours of the day. Late evening is sometimes a more desirable time for both departures and arrivals when the effects of density altitude are generally less pronounced.

High Altitude Takeoffs

As noted above, normally aspirated engines should be leaned for takeoffs at higher density altitudes. When a fuel flow indication is available, the following table may serve as a guide in leaning the M20J 200 HP Lycoming engine to obtain a maximum takeoff power mixture.

FUEL FLOW FOR MAXIMUM TAKEOFF POWER MIXTURE	
Density Altitude - Ft	Fuel Flow - GPH
Sea Level	17.0
4,000	15.0
6,000	14.0
7,000	13.5
8,000	13.0
9,000	12.0
10,000	11.5
11,000	11.0
12,000	10.0

Descents

Descending in the M20s normally involves power reduction because of their extremely low aerodynamic drag. Rapid descents with cruise rpm and very low manifold pressures allow piston rings to flutter, which eventually can cause them and the piston lands to break. When descending, prevent the possibility of ring flutter by adjusting propeller rpm to the lowest cruise setting allowed by the POH.

Prior to reapplying power, increase propeller rpm to an appropriate cruise or climb setting. It should not be necessary to adjust propeller rpm until fairly late on approach. Before descending through approximately 500 agl, move the propeller control to the maximum rpm position in preparation for a possible go-around. Since manifold pressure will be low, no annoying surge in rpm will occur. Should it be needed, maximum power will be available as soon as the throttle is advanced.

Turbocharged Mooneys

Before we get into the varieties of turbochargers on the line of Mooney engines, lets review what a turbocharger does. Since an engine is primarily an air-burner, the amount of power produced by the engine is a function of how much air-not just fuel-it can take in. As you climb with a normally aspirated engine the air for combustion becomes less dense, therefore the engine power out put decreases.
Stated in the simplest terms, a turbocharger consists of a pinwheel or turbine rotor connected by a shaft to another pinwheel or compressor rotor. By subjecting one end of this device to the forceful blast of exhaust gases coming out of the engines, we will cause the other end to spin at the same forceful speed and blow or pack more air into the intake side of the combustion process. There is a problem with this device however. If you compress air into the front end of the engine and burn it with more fuel, you will create more exhaust gas. The unit will then turn faster, blowing even more air in, resulting in more exhaust gas, more air, more gas, etc., until the unit self destructs. In order to prevent this catastrophic destruction the engineers developed a device that will limit or restrict the flow of exhaust gases to the turbocharger. This device is called a waste-gate.

The waste-gate's function is quite simple. When the waste-gate is open, exhaust gases are allowed to exit the exhaust system before reaching the turbocharger rotor. When the waste-gate is closed, all of the exhaust gases are trapped and forced to go through the turbocharger. Therefore a closed waste-gate means more power and an open waste-gate means less power.

The next step in applying the turbocharger technology is a method of controlling the waste-gate in order to provide a predictable and constant source of combustion air, which will maintain a predictable and constant power. The simplest solution is to wire the waste-gate part way open and be done with it. This is called a fixed-waste-gate system; mechanically simple and inexpensive but with some drawbacks, mainly because of the potential for over boosting. Another solution to waste-gate control is to provide a mechanical interconnect that closes the waste-gate as the throttle is opened, and at some high throttle setting the waste-gate closes all the way and you get maximum turbocharger output. This means you get a certain amount of boost at half throttle; more boost at two-thirds throttle, and still more as you advance the throttle. As you can see, the biggest disadvantage is the potential for over boosting and destroying the engine.

The next step in the evolution of waste--gate control came in the form of automatic controllers. In an automatic controller system the waste-gate actuation occurs outside the direct control of the pilot. There is no mechanical linkage between the waste-gate ad any cockpit control. Some types of automatic controllers are:

1. Absolute pressure controller - uses an aneroid device that expands as we go higher and connects to a needle valve that controls oil pressure in the vicinity often oil pressure-actuated waste-gate. As we go higher the aneroid expands, bears on the valve, admits oil pressure to the waste-gate actuator, and closes the waste-gate. The aneroid pressure is pre-set so the controller will try to maintain that pressure - e.g. if it is set to maintain 30" and you are on the ground at idle, your waste-gate will be fully closed!
2. Sloped controller - a variant of the absolute pressure controller hat incorporates an additional diaphragm in the controller that enables the controller to compare the preset aneroid upper deck pressure to the pressure called for by the throttle (lower deck pressure) and then maintain a certain deferential between the two pressures.
3. Absolute variable pressure controller - this system uses a mechanical interconnect between the throttle and the controllers output valve, regulating the controllers output by throttle position and maintaining a constant differential pressure.
4.Density differential controllers - most complicated and most expensive of the various types of controllers. It actually has two types of controllers in the single unit - a density controller for full throttle operation and a differential pressure controller for reduced throttle operation. The differential pressure portion senses the upper and lower deck pressures and positions the waste-gate to maintain a certain deferential pressure, and at high power settings the density controller senses the density altitude and will provide the waste-gate position required for that density altitude. Therefore, manifold pressure will peak out an inch or two higher on some days than on others, depending on prevailing density altitudes.

Now lets look at the Mooney turbocharged engines and the types of turbocharger/waste-gate systems.

M20K `231` - up to 1984 - Continental TSIO-360-GB, Rajay/Rotomaster, fixed waste-gate w/o intercooler.

M20K `231` - 1984 and up - Continental TSIO-360-LB1B, Rajay/Rotomaster, fixed waste-gate w/o intercooler.

M20K `252` - Continental TSIO-360-MB1, AirResearch, absolute variable pressure intercooler.

M20K `305 Rocket` - Continental TSIO-520-NB, AirResearch, absolute variable pressure controller

M20M `TLS` - Lycoming TSIO-540-AFIA, AirResearch, density-differential pressure-controller.

Read the POH to know what kind of over boost protection you have. The fixed waste-gate system on the 231 requires particular attention. Remember that partial throttle takeoffs are the norm and manifold pressure will tend to overshoot your target setting until you get used to the lag. Over boosting is a real possibility because of this built-in lag. The automatic system will keep you within manifold pressure limits if you have good oil pressure and good oil temperatures.

Cooling is extra critical in a turbocharged aircraft. Cooling is a very controversial issue with aircraft engines because air is the coolant upon which our engine depends, and air is a notoriously poor coolant because of its low density. Fuel cooling by rich mixtures tends to soften these considerations somewhat, but cooling by fuel accounts for only 10% - 15% of the typical Lycoming or Continental's cooling needs. You need air to cool your engine!

The higher you fly the more difficult is to keep the engine cool, despite the cold outside air temperature. This is because the engine cooling is affected more by air density than by air temperature, and as you go higher the density falls off at a faster rate than temperature. Remember, at high altitudes both air density and indicated airspeeds are low, and air flow through the cowling is low. If you can't maintain engine temps at FL 250 with cowl flaps, the only other option is to increase airspeed by descending!

Cruise altitude and power selections are many and varied - whatever your choice, follow the POH very precisely. For any given cruise percent-of-power setting, you might want to consider a setting with lower MP and higher RPM to provide better cylinder cooling. You also might want to consider a cruise percent-of-power setting that yields a TIT of 1550 degrees or less, since many Mooney Service Centers report that their experience shows longer cylinder life below these temperatures. Your Mooney Service Center can also adjust the cowl flaps manually by lengthening or shorten the rod that holds them in place. This could be done during seasonal temperature changes and applies to all Mooney models.

Leaning an aircraft engine - any aircraft engine - is not something to be approached haphazardly or in an ill-informed manner. this applies even more so to a turbocharged engine. Whether you choose best economy or best power, make all mixture changes in small steps to allow temperatures changes not to exceed 50 degrees F per minute. Monitor CHT oil temperature, TIT, and compressor discharge temp if applicable. Remember, you can shock heat your engine just as you can shock cool your engine.

The message for turbocharger Mooneys is very clear: Watch your engine temps and include the engine instruments in your scan, and be ready to make the necessary adjustments if CHT or oil temperatures start to head for the red-line. That means be ready to enrich the mixture, reduce the throttle, trim nose-down if need be, and open the cowl flaps.

Descent planning must include maintaining enough power to keep the engine from rapid cooling. This means some basic arithmetic based on a known rate of descent, ground speed, and distance to go to arrive at traffic pattern altitude at a comfortable speed. Lower RPM and drag devices will allow for a greater rate of descent while maintaining engine power with small reductions in MP.

After landing allow a minimum of 5 minutes below 1000 RPM to let the turbocharger spin-down and cool down. Circulating engine oil is all the coolant the turbo ever sees on the ground and it extremely important to keep it flowing.
Reference sources and suggested reading: "FLY THE ENGINE" by Kas Thomas.

VFR Traffic Pattern

NOTE: Touch-and-go landing practice is not recommended for retractable gear aircraft. Use full stop or stop-and go landings only.

1.0 APPROACHING AIRPORT (CTAF announcement/visual traffic check)
1.1 At pattern altitude reduce power approx 1 mi from airport
1.2 Complete pre-landing checklist
1.3 Plan a rectangular ground track

2.0 DOWNWIND LEG (CTAF announcement/visual traffic check)
2.1 Enter in level flight and 5 mi from runway
2.2 90 kt power, clean configuration, trim for level flight
2.3 Crab for wind correction, lower gear @ point opposite touchdown
2.4 1st GUMP check

3.0 BASE LEG (CTAF announcement/visual traffic check)
3.1 Turn @ 45° point or when landing traffic is abeam
3.2 Crab for wind correction
3.3 Partial wing flaps, retrim for 80 kt target airspeed
3.4 Power adjustment for desired altitude/rate of descent
3.5

4.0 FINAL APPROACH (CTAF announcement/visual traffic check)

4.1 Complete turn to final 1/4 to 1/2 mi from runway end
4.2 Full wing flaps and retrim for 70 kt (crosswind under 15 kt)
4.3 2nd GUMP check
4.4 Adjust power, transition to wing low wind correction "over the fence"

5.0 TOUCHDOWN
5.1 Maintain wing low wind correction
5.2 Apply full nose-up trim with smooth power reduction
5.3 Insure that main wheels contact runway first
5.4 Gently lower nose wheel after touchdown

6.0 AFTER CLEARING RUNWAY (CTAF announcement of intentions)
6.1 Retract wing flaps, open cowl flaps, retrim for takeoff
6.2 Secure fuel pump as required and lean for ground operations

7.0 REMAINING IN PATTERN
7.1 Turn to crosswind beyond departure end of runway
7.2 Landing aircraft occasionally give way to allow departures

8.0 DEPARTING TRAFFIC PATTERN
8.1 Continue straight out **or**
8.2 Make 45° turn past runway (to pattern side) at pattern altitude

Winter Operations

The following material is from an article, which first appeared in the Nov./Dec. issue of Flight Safety Foundation's Air Taxi/Commuter Safety Bulletin.

The pilot in command is responsible for seeing that his aircraft is free of ice, snow or frost. An aircraft ready for service must not have snow or ice adhering to its surface and all systems must be capable of normal operations. Under extreme cold conditions, some flight instruments will be sluggish and give false information. Gyros may require more time to erect and align.

During the walk around, a thorough check should be made for accumulations of snow, ice, slush and even sand, snow or ice impacted in the gear locks can cause erroneous gear indications. Flap surfaces should be inspected for possible damage caused during the previous landing and taxi operation.

Actuating and operating mechanisms can be frozen, and ports and inlets can become clogged with ice and snow. The fueling process, depending upon the temperature of the fuel, can either melt ice or snow on wings or cause surface moisture to freeze. That dry snow that looks like it will blow off during takeoff may have an ice coating beneath it after being melted by "warm" fuel and then refrozen. Any reasonable doubt should be resolved in favor of returning to the ramp for further inspection or deicing.

Tires can freeze to the ramp. If the aircraft will not move under normal power, don't force it. If you have any trouble getting the aircraft to move, have maintenance personnel glycol the tire area. Taxi guidelines may be obscured by snow; ensure that you are on the centerline. Parked aircraft may not be in proper position for the same reasons, and your wing tip clearance may be reduced.

Taxi with extreme care, flaps up, and as if no brakes are available and nose steering is ineffective. Avoid stopping with your nose gear on a patch of ice, especially if the surface has a high crown and the winds are gusty.

Before moving into the takeoff position, verify that the aircraft still meets the snow/ice-free criterion. Don't assume the snow will blow off during acceleration as ice may be underneath the snow. Frost is probably the most deceptive form of icing. Its effect of decreasing the lift-drag ratio makes it an insidious takeoff hazard. It forms on exposed aircraft surfaces when skin temperatures are below freezing while surrounding air temperatures are above freezing.

Directional control can be a problem during takeoff. Braking for control, until rudders become effective, can be particularly hazardous. A wheel that is locked and skidding on ice suddenly crossing a dry spot of runway can cause a tire to blow out, or worse, a violent swerve. If there is snow, slush or water on the runway, expect a longer takeoff roll. As the weather gets colder, the warmth that radiates from runways after sunset attracts many local birds. Be alert for the bird problem and report all sightings or strikes.

Caution must be used when flying over mountainous terrain. Icing is more intense in clouds on the windward side and over crests of mountains on the leeward side. Strong winds, possible wind shears and icing conditions can be expected.

Severe icing is usually confined to an area 200 to 500 ft. in depth, so, when encountered, change altitude immediately. Windshield icing increases the possibility of a mid-air collision. While your aircraft may have an ice-free windshield, how about the other guy? During descent and approach, bear in mind the likelihood of encountering super-cooled clouds at low altitudes. Increased exposure time in holding patterns at high-density airports can accentuate the problem.

The most severe clear icing conditions occur at temperatures between 0 degrees C and -10 degrees C in cumuliform clouds and freezing precipitation. Below -10 degrees C, either continuous ice or mixed rime and clear might occur. Weather frontal situations cause almost all of the severe icing conditions experienced in terminal areas.

Mooney Aircraft Pilots Association Safety Foundation

NOTES

CHAPTER 5. MOONEY MAINTENANCE

Inspections

As with all General Aviation aircraft, Mooneys are subject to regular inspections. As pilots, we should understand the work content of these inspections and consider the advantages of participating in them where possible. Such participation frequently consists of removal/replacement of inspection plates, which saves money and gives valuable insights into the aircraft and its operation. An overall appreciation of the work scope to be accomplished by the A&P mechanic or AI also aids in the subsequent evaluation, preflight inspection and the all-important first flight after the aircraft is returned to service.

Specific maintenance activities which should be carefully reviewed by the safety conscious pilot include painting, washing, landing gear/brake/tire maintenance, oil changes, autopilot maintenance, magneto disassembly, fuel tank resealing, exhaust system work, avionics additions, and service preparations after lengthy storage or inactivity.

Reproduced at the end of this chapter are pages from the Mooney Aircraft Service Manual, which detail 100 hr/annual inspections. This information will help the pilot to understand and intelligently evaluate maintenance, which has been performed on the aircraft by others.

Service and Maintenance Publications

The Mooney design incorporates unique features, which should be understood by owners and service technicians to insure proper aircraft maintenance. These are documented in Mooney Service and Maintenance (S&M) Manuals and Airworthiness Directives (A/Ds).

After an aircraft enters production the manufacturer invariably discovers additional safety or maintenance items which were not included or sufficiently emphasized in the Service Manual. To address these items, Mooney Aircraft Corporation issues Service Instructions (S/Is) "which pertain to items requiring attention during routine maintenance", and FAA approved Service Bulletins (S/Bs) "which deal with items requiring attention and/or changes for improved safety of flight."

The S/B Manual, containing both S/Bs and S/Is, can be purchased from Mooney Aircraft through a Mooney authorized Service Center. Service Bulletins are now available through a Mooney Aircraft link with MAPA's web page at www.mooneypilots.com.

Most S/Is and S/Bs are advisory and need only be complied with if the owner so chooses. Occasionally Mooney specifies that an S/B is mandatory, although the S/B is not legally required for FAR Part 91 operations unless the FAA follows up with an A/D on the subject. To verify which S/Is, S/Bs, and A/Ds have been accomplished; the specific airframe logbook or other maintenance records must be searched.

Critical S/Is, S/Bs and A/Ds

This section discusses a sample of Mooney S/I's, S/B's and A/D's of particular interest. Charlie Dugosh of Dugosh Aviation, Kerrville, TX, selected them from the total list of over 300.

Service Instruction M 20-80, August 15, 1987

This pertains to turbo-charger check valve clamps on some M-20K aircraft. Inspection (and replacement if necessary) is strongly advised.

Service Instruction M 20-83, February 20, 1988

This M20K S/I calls for modification, an inspection of the alternate air door magnetic latch every 100 hrs, and a replacement every 500 hrs.Failure of this latch can cause pieces to be ingested by the turbo-charger with serious damage.

Service Bulletin M 20-208B, August 18, 1989

Since the cabin failure of the Aloha Boeing 737, corrosion consciousness has gone up throughout the aviation community. Some years ago Mooney introduced a S/B calling for inspection of the tubular structure from within the cabin. Although this procedure requires about 10 man-hrs to complete, it's highly recommended since progressive corrosion can lead to serious weakening of the primary structure and very expensive repairs.

Included is the latest issue of the Service Bulletin, M20-208B, and a reprint "Rust and Corrosion" by Paul Loewen, only one of many horror stories on this subject. A significant change from earlier versions in issue -208B is hidden in item 10 at the bottom of page 2; this now allows polishing out more extensive areas of corrosion rather than (very expensive) tube replacement.

Service Bulletin M 20-217, March 26, 1979

Many aircraft up through 1968 had manually operated, hydraulically actuated flaps. A small valve position handle below the instrument panel allowed the pilot to actuate a hydraulic pump to lower the flaps. If these aircraft were flown above the maximum landing gear extended speed, V_{le}, it stressed the attachment point of the actuator brackets to the rear spar center splice and could cause cracks. Since V_{le} on these aircraft is relatively low, this failure has been common.

S/B M20-217 addresses this problem and calls for repetitive inspection every 500 hrs unless a repair or modification is made in which case no repetitive inspection is necessary.

Service Bulletin M 20-229A, February 12, 1986

Since the Challenger accident, the world has known that O-rings lose their resilience. Every Mooney owner also knows that the fuel caps have large O-rings that seal them closed. Less obvious is a small O-ring about the shaft that runs down the center of the cap. Both are important in keeping water out of the tanks.

S/B M20-229A calls for frequent inspection of the large O-ring around the cap (simply take a look at them every time you add fuel) and occasional lubrication with petroleum jelly or Tri-Flow. Whenever cracks appear, replace both the large and small O-rings.

Airworthiness Directive 90-04-06, February 15, 1990 (and referenced Lycoming S/I and S/B)

This recent AD applies all models up through M20J. An inspection of the oil line between the governor and prop is required within 25 hrs of service. Note that replacement parts are currently in short supply, so talk to your shop before the 25 hrs runs out.

Airworthiness Directive 77-17-04, July 7, 1978 (and Mooney S/B M20-205B)

This A/D applies to inspection for cracks in control wheel shafts on pre-J models. This is a repetitive inspection every 500 hrs unless the shaft is replaced with a strengthened configuration. Replacement is a good practice simply to avoid the subsequent inspections.

Ed Penny has given the history of this A/D: The only known occurrence of cracked shafts was in a flight school operation where students repeatedly banged the control wheel against the stops when verifying controls free. It is therefore very unlikely that any cracks will be found, but the inspection (or replacement) must be accomplished to keep the plane legal.

Airworthiness Directive 76-07-12, August 30, 1977

This often-overlooked A/D applies to nearly all M20A through M20J models but is very easy to comply with. Every 100 hrs one must perform regular run-up procedures and "allow the engine to reach operating temperatures and perform a normal magneto check". Then, with the engine at idle, switch the mag to "OFF" and see if the engine quits. If the engine quits, your mags have passed the test.

Although the pilot may perform these checks, you must enter this test in your Airframe Log to make the plane legal.

Pilot/Owner Maintenance

The Federal Aviation Regulations spell out what pilots (who are not certificated airframe and power plant mechanics or repairmen) may do to maintain their aircraft. It is called "preventive maintenance" to distinguish it from more complex maintenance, repairs, rebuilding or alterations.

FAR Part 43 allows preventive maintenance to be performed by a certificated pilot on an aircraft owned or operated by that pilot, provided the aircraft is not used commercially. The pilot who does the work and makes the logbook entry usually approves the aircraft for return to service, but not always. For example, the regulations permit a student to perform preventive maintenance on an aircraft operated by him, but a person with at least a private pilot certificate must approve the aircraft for return to service.

A logbook entry containing the following information must be made before the aircraft is again operated:

A. A description of the work performed.

B. The date the work was completed.

C. The name of the person performing the work.

D. If the work has been performed satisfactorily, the signature, certificate number and kind of certificate held by the person approving the work. This signature constitutes the approval for return to service.

Reproduced here is the appendix to FAR 43, which lists all maintenance activities that may be performed by the licensed pilot. Items preceded by an asterisk (*) are not relevant to preventive maintenance for most Mooneys.

1. Removal, installation, repair of landing gear tires.

* 2. Replacing elastic shock absorber cords on landing gear.

* 3. Servicing landing gear shock struts by adding oil, air, or both. (The Mooney nose gear shock strut is no longer required and may be removed permanently per S/B.)

4. Servicing landing gear wheel bearings, such as cleaning and greasing.

5. Replacing defective safety wiring or cotter keys.

6. Lubrication not requiring disassembly other than removal of nonstructural items such as cover plates, cowlings, and fairings.

* 7. Making simple fabric patches not requiring rib stitching or the removal of structural parts or control surfaces. In the case of balloons, the making of small fabric repairs to envelopes (as defined in, and in accordance with, the balloon manufacturers instructions) not requiring load tape repair or replacement.

8. Replenishing hydraulic fluid in the hydraulic reservoir.

9. Refinishing decorative coating of fuselage, balloon baskets, wings tail group surfaces (excluding balanced control surfaces) fairings, cowlings, landing gear cain, or cockpit interior when removal or disassembly of any primary structure or operating system is not required.

10. Applying preservative or protective material to components where no disassembly of any primary structure or operating system is involved and where such coating is not prohibited or is not contrary to good practices.

11. Repairing upholstery and decorative furnishings of the cabin, cockpit, or balloon basket interior when the repairing does not require disassembly of any primary structure or operating system or interfere with an operating system or affect the primary structure of the aircraft.

12. Making small, simple repairs to fairings, nonstructural cover plates, cowlings, and small patches and reinforcements, but not changing the

contour so as to interfere with proper airflow.

13. Replacing side windows where that work does not interfere with the structure or any operating system such as controls, electrical equipment, etc.

14. Replacing safety belts.

15. Replacing seats or seat parts with replacement parts, approved for the aircraft, not involving disassembly of any primary structure or operating system.

16. Troubleshooting and repairing broken landing light wiring circuits.

17. Replacing bulbs, reflectors, and lenses of position and landing lights.

* 18. Replacing wheels and skis where no weight and balance computation is involved.

19. Replacing any cowling not requiring removal of the propeller or disconnection of flight controls.

20. Replacing or cleaning spark plugs and setting spark plug gap clearance.

21. Replacing any hose connection except hydraulic connections.

22. Replacing prefabricated fuel lines.

23. Cleaning or replacing fuel and oil strainers or filter elements.

24. Replacing and servicing batteries.

* 25. Cleaning of balloon burner pilot and main nozzles in accordance with the balloon manufacturer's instructions.

26. Replacement or adjustment of non-structural standard fasteners incidental to operations.

* 27. The interchange of balloon baskets and burners on envelopes when the basket or burner is designated as interchangeable in the balloon type certificate data and the baskets and burners are specifically designed for

quick removal and installation.

28. The installation of anti-misfueling devices to reduce the diameter of fuel tank filler openings provided the specific device has been made a part of the aircraft type certificate data by the aircraft manufacturer, the aircraft manufacturer has provided FAA-approved instructions for installation of the specific device, and installation does not involve the disassembly of the existing tank filler openings.

29. Removing, checking, and replacing magnetic chip detectors.

The regulation contains a caveat: Section 43.13 requires that a person performing preventive maintenance use methods, techniques and practices acceptable to the FAA, and tools, equipment and test apparatus necessary to assure completion of the work in accordance with accepted industry practices.

The work must be done in such a manner and use materials of such a quality, that the condition of the aircraft, airframe, aircraft engine, propeller or appliance worked on will be at least equal to its original or properly altered condition.

Maintenance Records

Requirements for maintenance records are contained in FAR 91.173, summarized here:

1. The registered owner or operator shall keep the following records until the work is repeated, superseded, or for one year:

Records of maintenance, alterations, required or approved inspections, as appropriate, for each aircraft, engine, propeller, rotor, and appliance. Records must include description of the work, date of the work, signature and certificate number of person approving work for return to service.

2. The following records must be retained and transferred with the aircraft when sold:

i. Airframe total time in service.

ii. Current status of life limited parts.

iii. Time since overhaul on items required to be overhauled.

iv. Current inspection status including times since last inspection.

v. Current status of Airworthiness Directives including method of compliance.

vi. List of current major alterations.

3. A list of defects furnished to a registered owner or operator under FAR 43.11 (annual/100 hr/progressive inspections), shall be retained until the defects are repaired and the aircraft is approved for return to service.

4. When a fuel tank is installed within the passenger compartment or a baggage compartment pursuant to Part 43, a copy of the FAA Form 337 shall be kept on board the modified aircraft by the owner or operator.

Mooney Aircraft Pilots Association Safety Foundation

CERTIFIED AIRFRAME AND POWERPLANT MECHANIC MAINTENANCE.

TIME LIMITED PARTS and 25 - 50- 100 HR/ANNUAL INSPECTION PROCEDURES

The owner/operator should be aware of work which should be performed to his/her aircraft at various times and just what actions are required to be performed at each and every inspection. The following pages have been taken directly from the Mooney Service Manuals.

TIME LIMIT COMPONENTS

It is recommended that overhaul or replacement of components should be accomplished not later than the specified period of operation for that component or in accordance with manufacturers service data or airworthiness directives.

The specified overhaul time limits, if applicable to a component, do not constitute a guarantee that the component will reach that time limit without requiring maintenance.

NOTE

"ON CONDITION" items are to be repaired, replaced or overhauled when inspection or performance reveals an unserviceable condition.

OVERHAUL AND REPLACEMENT SCHEDULE

ITEM		RECOMMENDED OVERHAUL OR REPLACEMENT TIME LIMITS
LANDING GEAR Actuator No-Back Spring		1000 Hours
All other Components		On Condition
POWERPLANT		
Engine	(TSIO-360)	1800 Hours
	(O-360, IO-360 & TSIO-540)	2000 Hours

Propeller	(McCauley)	1500 Hours
	(Hartzell)	2000 Hours
Magneto		Engine Overhaul (TBO)
Induction Air Filters (Paper)		500 Hours
All other Components		On Condition
FUEL & OIL SYSTEM		
Fuel Selector Valve (Anderson-Brass)*		500 Hours
Flexible Hoses (ALL)		7 years or Engine O/H, whichever occurs first.
All other Components		On Condition
INSTRUMENTS		
Vacuum Regulator Garter		100 Hours
Filter Filters - Vacuum Pump		500 Hours or once a year
Filters - Gyro Instrument		500 Hours or once a year
Other Components		On Condition
ELECTRICAL COMPONENTS		
All Components		On Condition
FLIGHT CONTROLS		
All Components		On Condition
MISCELLANEOUS SYSTEMS		
Vacuum Pump, Primary (Airborne)		500 Hours & Engine O/H (TBO)
Stand-by Vacuum Pump		Inspect @ 500 Hours
E.L.T. Battery		2 years or 1 Hour total use time
Oxygen Cylinders		
Lt. Wt. Steel Cylinders		24 years or 10,000 recharge cycles
Composite Cylinders		15 years or 10,000 recharge cycles
All other Components (excluding Avionics)		On Condition
AVIONICS		Refer to Manufacturers Publications

* Applicable on S/N's 24-0084, 24-0378 thru 24-1176 only.

AIRCRAFT INSPECTION

Aircraft 100-hour and annual inspections cover, in addition to examining the aircraft proper, a review of the status of compliance with current Federal Aviation Regulations. This review includes inspection of the Airplane Flight Manual, Aircraft Log Book, Engine Log Book, Registration Certificate, Airworthiness Certificate, Weight & Balance Record, Lycoming or Continental Service Information, Aircraft Radio Station License (if applicable), FAA Airworthiness Directives, and Mooney service documents.

ENGINE FUNCTIONAL CHECK

Prior to a scheduled 100-hour or annual inspection, and/or 25 hours after installation of new or overhauled engine, wash down the engine and engine components. Then perform an engine runup in accord with procedure recommended in the Airplane Flight Manual. Make a record of all malfunctions and abnormalities. After the engine runup, complete a differential (hot engine) compression check. To verify correction of malfunctions and abnormalities, perform a second engine runup and a flight test after completing the inspection.

25 HOURS - INSPECTION

The inspection does not require removal of access panels or disassembly of all components; however, it should include completion of all lubrication and service requirements. Inspection should be extensive enough to detect any damage or condition that might jeopardize flight safety.

1. Visually inspect propeller, spinner, and cowling, remove cowling.
2. Inspect and clean induction air filter if aircraft has been operating under dusty conditions. Check operation of alternate air door. Check Ram air door operation Models E, F, & J, S/N 24-0001 thru 24-3153.
3. Inspect engine compartment for evidence of fuel, oil or exhaust leaks.
4. Check security and condition of equipment installed on engine.

5. Inspect fuselage, wing and empennage for external evidence of damage. Pay particular attention to scratches and dents.

6. Inspect windshields and windows for crazing, cracks, and scratches.

7. Check control systems for binding, excessive freeplay, and damage.

8. Check pilot and static systems for obstructions.

9. Inspect aircraft exterior for security of bolts, screws, etc.
10. Check and service battery.

50-HOUR INSPECTION

The 50-hour inspection includes all requirements for the 25-hour inspection, plus the necessary removal of inspection doors, panels, or fairings. After the first 25 hours of operating time, a new, remanufactured, or newly overhauled engine should be given a 50-hour inspection including replacement of the lubricating oil.

1. **ENGINE**

A. Drain engine oil sump.

B. Remove and clean suction oil strainer; reinstall strainer and plug. Safety wire strainer plug.

C. Remove and replace the full-flow oil filter cartridge.

D. Drain and clean fuel strainer.

E. Remove and clean fuel injector fuel strainer.

F. Service engine oil sump with proper type, grade, and amount of lubricating oil.

G. Inspect engine intake and exhaust systems for evidence of leakage and looseness.

H. Check spark plug elbows and shielding nuts for security.

I. Check cylinders for evidence of overheating.

J. Check turbocharger for security of clamps and attachments.

K. Check baffles for secure anchorage, close fit around cylinders, and freedom from cracks.

L. Check engine controls for full travel, -freedom of movement, and security.

M. Visually check -fuel and oil lines for security of connections and evidence of leakage or damage.

N. Visually inspect induction air system; check operation of alternate-air door.

2. **PROPELLER**

A. Check propeller hub and spinner for general condition, looseness, and oil leakage.

B. Inspect blades for nicks and cracks. Repair prior to next flight.

3. **CABIN**

A. Check brake and parking brake control systems for proper operation and fluid level.

B. Check trim system and indicator for free operation and travel.

C. Check cabin and baggage doors for damage, proper operation, and sealing.

D. Check cabin, instrument panel, glareshield, position, anticollision •landing and taxi light.

E. Check fuel selector valve, gascolator, and boost pump for proper operation.

F. Check oxygen system (if installed).

4. **LANDING GEAR**

A. Check tires for proper inflation, cuts, blisters, slippage, or excessive wear.

B. Check shock discs for proper extension at aircraft static weight. C. Check hydraulic brakes for wear, warpage and proper installation.

5. **WINGS**

A. Check surfaces and tips for damage.

B. Check ailerons, aileron attachments, and bellcranks for damage and proper operation.

C. Check flaps and attachments for damage and proper operation.

D. Lubricate controls if necessary.

6. **FUSELAGE and EMPENNAGE**

A. Check stabilizer, elevators, fin, and rudder for damage and proper attachment.

B. Lubricate controls if necessary.

C. Check Trim System for proper operation.

7. **LIGHTS**

A. Check operation of exterior and interior lights.

B. See above for repetitive 50 Hour inspections and servicing of components information.

100-HOUR INSPECTION (or ANNUAL)

The 100-hour (or annual) inspection is a thorough, searching inspection of the entire aircraft. Preparation for the inspection includes the removal of fuselage, wing, and empennage inspection doors, cover plates, and fairings at all systems attach, hinge, and bearing locations (including wing and empennage to fuselage mating points). Operating limit replacement and special testing of components is to be included at this-interval when applicable. Comply with applicable FAA Directives, AD Notes, and applicable Mooney and Vendor mandatory Service Bulletins and Instructions. Check for aircraft conformance to FAA Specification 2A3. Recommended 100-hour and special inspection requirements are outlined in the following paragraphs.

1. ENGINE INSPECTION

Prior to the inspection, remove the engine cowling and propeller spinner. Wash down the engine and engine compartment. Then perform an engine runup in accord with the procedure recommended in the Lycoming or Continental Operators Manual, To verify correction of malfunctions and abnormalities, perform a second engine run up and flight test after the 100-hour inspection engine set-up.

A. Complete a differential (hot engine) compression check: clean and gap or replace spark plugs if necessary.

B. Inspect engine for evidence of fuel and oil leakage. Inspect oil cooler and oil hoses for condition and security.

C. Drain engine oil sump; remove, clean, and inspect oil suction screens, reinstall and safety. Remove full-flow oil filter cartridge; replace with new cartridge and safety. Check crank case breather hoses for obstruction. Safety wire oil filter installation.

D. Refill engine oil sump with the proper type, grade, and quantity of lubricating oil.

E. Inspect fuel injector and all fuel line connections for security and condition.

F. Remove, inspect and clean fuel selector valve or gascolator strainer, reinstall strainer, lubricate detent track, ball and spring disc. Inspect fuel lines and connections, pressure check fuel system with mixture control at IDLE CUTOFF and BOOST PUMP ON.

G. Inspect all air ducting and connections in the heating and induction air systems for leaks. Remove and clean induction air filter; replace at 500 Hrs. Leak check all exhaust manifold connections, engine exhaust manifolds and muffler connections. Inspect alternate air door on E, P, & J, Models for proper preload. To inspect, remove lower cowling and PUSH on alternate air door seal bolt with an appropriate spring scale. A preload of 3 to 4 pounds should be required to start door to open. Add or delete AN960-416L washer under bolt head to obtain proper tension. Replace all components removed. Coat Seal with TEFLON spray/lubricant.

CAUTION

CHECK SECURITY of seal to Induction Box Door. If necessary use (3M) EC1403 cement to secure seal to door.

H. Check magnetos for grounding and synchronization; check magneto points for condition, clearance, and timing. Inspect distributor block for erosion and cracks. Check cam follower felt for proper lubrication, and remove excessive oil from breaker compartment. Inspect magneto pressurization. Repair or replace components if required, per Bendix SB No. 612 at 500 Hrs. for routine maintenance.

1. Check baffles for secure anchorage, cracks, holes, deformation, and for close fit around cylinders. Check cylinders for burned paint and cracked or broken fins. Check baffle sealant.
2. Inspect accessory case, starter, alternators, vacuum pumps hose, firewall and fittings for security or damage.

3. Inspect turbocharger for cracks or damage.

I. Check engine and propeller controls for free operation, proper lubrication, full travel, and security of attachment.

J. Inspect tubular engine mount for cracks; check all bolts and rubber mounts for security and condition.

K. Check engine fuel pump pressure.

L. Inspect and reinstall cowling. Check cowl flaps for operation, condition, proper opening and position indication.

M. Check battery cables, electrical wiring, and ignition harness for condition, secure anchorage, loose terminals, and burned or chaffed insulation.

N. Inspect batteries, battery mount areas, and vent system for condition and corrosion. Check blast tube for obstruction. Flush battery mount areas with soda solution to neutralize corrosive action if necessary.

0. Inspect exhaust stacks for burned areas, cracks, distortion and looseness.

P. Inspect exhaust couplings, seals, clamps and slip-joints for cracks, deformation, leaks and security.

2. **PROPELLER INSPECTION**

A. Remove spinner (if not already removed).

B. Check security of propeller installation.

C. Check hub bolts for security and damage.

D. Inspect hub components for damage or leaks and blades for cracks and nicks. Repair prior to next flight.

E. Check high and low blade angles. Refer TO appropriate AFM/POH for correct blade angles.

F. Inspect spinner and bulkhead for cracks and condition.

G. Check spinner bulkhead for correct interference fit with prop cylinder. (Use Teflon Tape to obtain correct fit).

3. LANDING GEAR AND RETRACTION SYSTEM INSPECTION

A. Check tires for proper inflation, cuts, blisters, slippage, or excessive wear. Replace with new, approved, tire if necessary.

CAUTION

Always run at least 5 landing gear retraction cycle checks after any tire has been removed and/or replaced before flying the aircraft.

B. Check wheels for cracks, distortion, misalignment, and corrosion or bolt failure. Check condition of felt seals and bearings; repack bearings at 250-hour intervals.

C. Check brakes for warpage or wear.

D. Check hydraulic reservoir for proper fluid

level.

E. Check hydraulic brake lines and hoses for leakage, dents, cracks chafing, kinks, and security.

F. Check parking brake system for proper engagement and release.

G. Jack aircraft as recommended.

H. Check nose gear for cleanliness and damage. Check nose gear retraction tube bungees for sheared or broken roll pins.

NOTE

Maximum allowable towing damage on leg assembly is 1/32-inch dent. No repair allowed on heat-treated landing gear components.

I. Check nose wheel steering mechanism for adjustment, alignment, corrosion, and lubrication.

J. Check main gear for cleanliness or damage. Check shock disc gap. Check over center torque values.

K. Check landing gear retraction linkage, bell cranks. pivots, and bearings for wear, damage, distortion, misalignment, corrosion, cleanliness, and lubrication.

L. Check landing gear actuator for security of mounting, cleanliness, and indication of overheating or damage.

M. Perform landing gear operational check.

4. FUEL SYSTEM INSPECTION

A. Inspect fuel tank exterior for evidence of fuel seepage or stain.

B. Drain tank and inspect tank interior when seepage is evident.

C. Check fuel tank drains for leakage, sediment, or water contamination.

D. Check fuel-tank vents for obstruction.

E. Check fuel selector valve for proper tank selection, smooth operation, or any leakage when in OFF position.

F. Check gascolator for leakage; check sump for sediment, water or other contamination.

G. Check electric boost pump for leaks, security of mounting, adequate fuel pressure, switch operation, and condition of wiring and electrical connections and proper operation.

H. Check fuel quantity gauges and transmitters for security of mounting and condition of wiring and electrical connections.

I. Check fuel tank filler port for cleanliness, cap security, and condition of servicing placards. Check fuel filler cap O'rings for condition and replace if needed.

5. EXTERIOR INSPECTION

A. Inspect fuselage exterior surfaces for corrosion, damage, loose or popped rivets, dents, oil-cans (stretched skins), scratches, cracks, or deteriorated paint.

B. Inspect windshields and windows for cracks, crazing, scratches, condition of sealant, and security of installation.

C. Inspect wings, flaps, and ailerons for corrosion, damage, loose or popped rivets, dents, scratches, cracks, condition of attaching points, lubrication, freedom of operation, free-play travel, and balance weight attachment.

D. Inspect empennage for corrosion, damage, loose or popped rivets, free-play, dents, scratches, condition and lubrication of hinge points, attachment of balance weights and freedom of operation, manually and electrically.

E. Inspect cabin door and doorframes for damage, corrosion, nicks, dents, hinge security and lubrication.

F. Inspect cabin door lock mechanism for lubrication and proper engagement.

G. Inspect the baggage door and baggage compartment for damage, corrosion, warpage, hinge security, condition to doorframe and door seals, condition and operation of door locking mechanism, and condition of cargo restraints/tiedowns.

H. Inspect ventilating system drain line for obstruction.

I. Inspect landing and taxi lights for security, conditon and proper adjustment.

6. INTERIOR INSPECTION

A. Inspect seats, seat tracks, and upholstery for cleanliness and mounting security; check seats for condition and operation of position locks; inspect seat structure for cracks, deformation, corrosion, and mechanism lubrication.

B. Inspect safety belts and attaching brackets for cleanliness, condition, latch operation, and security of attachment.

7. **INTERNAL INSPECTION**

   A. Open access panels and inspection doors, and remove fairings as required.

   B. Inspect wing-attaching bolts for proper torque and safetying and evidence of damage or corrosion. (Interior side panels will require removal to accomplish this inspection).

   C. Inspect forward side of firewall for damage.

   D. Inspect tubular structure for corrosion or damage (interior panels and insulation may require removal).

   E. Inspect wing ribs and stringers for cracks and evidence of damage or corrosion.

   F. Check wing spars for damage, distortion, cracks, or corrosion.

   G. Check electrical wiring, fuel, oil and hydraulic lines, and air ducts for security, damage, interference, chaffing, or de-bonding.

NOTE

Seal all receptacles and plugs outside cabin environment with Dow Corning #4.

   H. Check wing interior for foreign material, corrosion, and evidence of fuel leakage.

8. FLIGHT CONTROL INSPECTION

A. Inspect control column and control wheels for full travel, proper rigging, free-play, binding, security of mounting, proper lubrication, and direction of control surface movement with relation to control movement.

CAUTION

All flight control components should be checked to verify that all moisture drain holes are free of obstructions.

B. Inspect elevator system linkage for rigging, travel, stop adjustment, condition of bearings and bell cranks, wear on downspring eyes, cable pulley and fittings, security of mounting, damage, corrosion, proper lubrication and proper relation to control movement.

C. Inspect aileron system linkage for damage, corrosion, lubrication, rigging, travel, stop adjustment, condition of bell cranks, pivots and rod end bearings, and link bolt security.

D. Inspect rudder system linkage for damage, corrosion, lubrication, security of link bolts and rod end bearings; check for free movement of toe-brake pedals and proper rudder and nose wheel travel.

E. Inspect stabilizer trim control system for security and proper adjustment, shaft and stop nuts for proper rigging, trim control wheel for smooth operation, universal joints for free-play and good working order, actuator threads for lubrication, linkage for corrosion, and guide blocks for looseness or excessive wear.

F. Inspect flap system for rigging, travel, and stop adjustment, flap rods, interconnects, and bell cranks for corrosion, security, and lubrication,

NOTE

i. All control rigging checks should be made with the aircraft jacked and leveled and with the landing gear retracted.

NOTE

ii. Some elevator trim tubes have poly tape wrapped at bulkhead penetrations. If tape shows signs of wear, rewrap (1/2 lap) tube with 2" wide Y9265 polyurethane tape. Trim tubes, without tape, which show signs of abrading grommet should be wrapped. See SB M20-185.

iii. Maximum tube wear is .007 in. per wall or .014 in. diameter reduction.

9. INSTRUMENT INSPECTION

A. Inspect all instrument wiring and plumbing for condition and proper connections.

B. Clean and inspect vacuum filter. Replace garter filter on vacuum regulator.

C. Check vacuum regulator at vacuum manifold. Check operation of high-and low-vacuum warning lights or vacuum gauges.

D. Inspect all instruments for proper pointer indication, range and limit markings, condition of indicator markings, cracked or loose glass, slippage marks, and security of installation.

E. Check compass for proper lighting, compensation, security of mounting, liquid leakage, and discoloration. Swing compass at annual inspection and after any new equipment has been installed.

F. Inspect altimeter for scale error, discolored markings, proper pointer readings, setting knob freedom, and synchronization of barometric scale with reference markers.

G. Inspect flight panel for security of mounting, condition of shock mounts, freedom from interference with structure, and condition of ground straps.

H. Inspect pilot head for port obstruction; check lines for cracks, dents, kinks, proper bend radius, and security of attachment. Drain system and check for leaks. Check alternate static pressure source.

10. ELECTRICAL FUNCTIONAL TEST

A. Check operation of navigation lights.

B. Check operation of landing light and taxi lights.

C. Check operation of dome lights and cigar lighter.

D. Check operation of ant collision lights.

E. Check operation of instrument and placard lights. Check rheostat.

F. Check operation of pitot head heater.

G. Check operation of cluster gauge.

H. Check operation of fuel gauges.

I. Check operation of annunciator light press-to test switch.

J. Check operation of ignition switch, and starter solenoid.

K. Flight check operation of landing gear position lights and warning horn.

L. Flight check operation of stall warning horn.

M. Check operation of "Prop De-Ice" (if installed). Push switch "ON", observe prop de-ice ammeter for needle in green arc 8 to 12 AMPS and fluctuation every 90 seconds as heating elements are switched.

11. POST INSPECTION FLIGHT TEST

Flight-test the aircraft to verify correction of all malfunctions and abnormalities. Make proper entries in aircraft log book.

Mooney Aircraft Pilots Association Safety Foundation

MOONEY AIRCRAFT CORPORATION
100 Hour-Annual Inspection Guide

AIRFRAME SECTION: (con't.)	MECH	INSP
5. Lubricate flight control system guide blocks, hinge points, rod end bearings & bell cranks.		
6. Inspect all wing, fuselage & empennage drain holes for distribution.		
7. Inspect empennage trim system for proper operation & rigging.		
8. Inspect downspring end loops, cable & pulley for wear & corrosion.		
9. Inspect flap system for proper operation & rigging; lubricate in accordance with Mooney Service & Maintenance Manual.		
10. Inspect flight instruments, filters & vacuum system for proper operation, marking, and condition; clean vacuum air filter.		
11. Inspect cabin lights, circuit breakers & electrical components for proper operation.		
12. Check operation of stall warning system.		
13. Inspect P.C. system components for security, leaks & proper operation; servo seals for deterioration, all other auto-pilot components for security & proper operation.		
14. Inspect vacuum step for security & proper operation; fixed step for security& damage.		
15. Inspect wing interior in fuel tank area for fuel leaks, fuel tank vents for obstructions & fuel filler caps for security & proper operation.		
16. Inspect cabin & baggage doors for condition, proper operation & sealing.		
17. Inspect windshield & windows for cracks, crazing, scratches & distortion.		
18. Inspect seats, seat belts & shoulder harnesses for security, proper operation & condition.		
19. Inspect compass & compass deviation card for proper indication & compensation. (Refer to Mooney Service Bulletin M20-150A)		
20. Inspect all radio equipment for proper installation & operation.		
21. Inspect cabin for proper sealing.		
22. Inspect oxygen system for leaks, proper valve operation & filler for safety of operation. (If installed).		
LANDING GEAR OPERATIONAL CHECK:		
1. Raise aircraft on jacks.		
2. Inspect brakes, hydraulic brake cylinders & hydraulic system for leaks and general condition: Service reservoir with MIL-H-5606 (RED) fluid.		
3. Remove wheels, inspect, repack bearings, reinstall and safety lubricate brake guide pins using Silicone-based lubricant. Check wheels for free rotation & proper brake action.		
4. Lubricate & inspect landing gear pivot points & moving parts.		
MANUAL GEAR RETRACTION SYSTEM:		
1. Raise aircraft on jacks.		
2. Check operation & rigging.(pre-loads).		
3. Check warning system light & horn.		
4. Check down lock preload (Mains & Nose).		
5. Check doors for proper closing.		
6. Check retract lever welds for cracks.		
ELECTRIC GEAR RETRACTION SYSTEM:		
1. Raise aircraft on jacks.		
2. Check operation & rigging.		
3. Check warning system lights, horn & visual indicator.		
4. Check air pressure safety switch or squat safety switch.		
5. Check down lock preload.		
6. Lubricate actuator gear box (Dukes & ITT actuators only).		
7. Check doors for proper closing.		
8. Check emergency system by lowering gear using emergency gear extension system. Do not attempt gear retraction using emergency system.(Refer to MAC S & M manual).		

ELECTRIC GEAR RETRACTION SYSTEM: (con't.)	MECH	INSP
9. Inspect shock absorbers (main & nose gear) in accordance with Mooney Service & Maintenance Manual.		
FIXED GEAR:		
1. Inspect landing gear fairing (M20C only).		
2. Check air seals in wheel well areas.		
POST-INSPECTION OPERATIONAL CHECK: (Refer to Mooney Owner's Manual or POH)		
1. Check propeller governor operation with engine running at 2000 RPM & pitch control at low pitch (High RPM): When propeller control is pulled out to high pitch (low RPM), engine speed should decrease at least 500 RPM.		
2. Check ease of operation for all engine controls with engine running.		
3. Check generator/alternator output & indication.		
4. Check oil pressure indication.		
5. Check fuel pressure indication.		
6. Check fuel quantity indication.		
7. Check cylinder head temperature (CHT) indication.		
8. Check oil temperature indication.		
9. Check idle RPM, idle mixture & idle cut-off.		
10. Check propeller pitch through complete range.		
11. Check operation of cabin & panel lights.		
12. Check Radios/Avionics operation.		
13. Check Auto Pilot operation.		
14. Check magneto drop and grounding circuits.		
15. Check operation of brakes.		
16. Check fuel selector valve for smooth operation.		
17. Test vacuum warning lights & instruments for proper operation.		
18. Flight check gear-up warning horn at 12" manifold pressure (MP) (M20J prior to S/N 24-3154), 14-16" MP (M20K[231, 252]) & with throttle 1/4 -3/8 inch from idle position (M20L, M20M, M20R, M20S, M20J (after S/N 24-3154) & M20K[Encore])		
19. Flight check aircraft flight control rigging.		
20. Flight check P.C. or other Autopilot systems for proper operation.		
21. Check cabin ventilation and heating system for carbon monoxide.		
22. Check EGT gauge and any other items of installed equipment.		
23. Check flap position indicator (Takeoff & Full down).		
24. Check trim position indicator.		
25. Other checks. (Specify as necessary)		

REMARKS:

Revised - April, 1999

Mooney (M20B-M20C-M20D-M20E-M20F-M20G-M20J-M20K-M20L-M20M-M20R-M20S

MOONEY AIRCRAFT CORPORATION:
100 HOUR - ANNUAL INSPECTION GUIDE:
M20L-PFM3200:

Owners Name...................... Address.........................:
Reg. No.......... A/C Serial No.............. A/C Tach Time..........:
Date of last Annual............. Engine Model & S/N.................:
Prop Design & S/N............... Engine Time........................:
Brand of oil & Weight used...................*NOTE* MOBIL 1 ONLY!!!:

1. Is Approved flight or owners manual in aircraft? Yes....No:...:
   a. Current and in proper condition?............. Yes....No:...:
2. Are current log books in aircraft?.............. Yes....No....:
   a. Current and in proper condition?............. Yes....No....:
3. Is Registration Certificate in aircraft?......... Yes....No....:
   a. Current and in proper condition?............. Yes....No....:
4. Is Airworthiness Certificate in Aircraft?........ Yes....No....:
   a. Current and in proper condition?............. Yes....No....:
5. Is Weight & Balance Record in Aircraft?.......... Yes....No....:
   a. Current and in proper condition?............. Yes....No....:
6. Is All applicable factory service information complied with........................ Yes....No....:
7. Are All applicable FAA Airworthiness Directives complied with........................ Yes....No....:

NOTE: This sheet is a guide only. Refer to the specific model service manual for aircraft, engine and propeller inspections.

Mechanic Signature............... Inspector Signature.................:

[ENG]INE SECTION: ([Ref]er to engine manufactures [Man]ual & Mooney Service & Maintenance Manual for appropriate model.)	MECH INTL	INSP INTL
1. Remove and clean engine cowling & baffling; Inspect for cracks, wash engine ....:		
2. Perform a hot engine differential compression check: CYLINDER READING: 1.......2.......3.......4....... 5.......6.......:.......:		
3 Inspect firewall for proper sealing and freedom from cracks.........:		
4. Inspect tubular engine mount for cracks, Engine mount bolts, & rubber mounts for security.........:		
5. Inspect starter & starter terminals ....:		
7. Inspect exhaust system for leaks, & cracks:		

PROPELLER SECTION:	MECH INTL	INSP INTL
1. Remove propeller spinner and check for cracks. ....:		
2 Inspect Hartzell Propeller hub for grease leakage: Check hub bolts & mounting bolts for proper torque: Inspect blades for cracks, nicks, & dents: Lubricate as needed (Refer to appropriate Manufactures Handbooks)..........:		
3. Reinstall spinner, check for correct interference fit with prop.........:		

NOTE: Check Propshaft, Gear Box, & Engine Torsional Coupling (Refer to Porsche Aviation Products Maintenance Manual). ...:	MECH INTL	INSP INTL

LUBRICATING SYSTEM:	MECH INTL	INSP INTL
1. Drain Engine Sump & Oil Reservoir: Change Oil Filter..........:		
2. Take Oil Analysis sample: Send to Porsche Aviation Products. ....:		
Note: Refer to Porsche Engine Service Manual: USE ONLY MOBIL 1 AUTOMOTIVE OIL:———:		
3 Check engine for oil leaks: (note & correct)		
4 Inspect condition of oil cooler :		
5 Inspect all Hoses, tubing, Fittings, Valve		

IGNITION SYSTEM:	MECH INTL	INSP INTL
1. Remove and inspect spark plugs. (clean & regap)..........:		
NOTE: New Spark Plugs Installed Each 300 Hours:		
2. Inspect ignition harness for general condition, free from fraying or chaffing..........:		

ENGINE COOLING SYSTEM:	MECH INTL	INSP INTL
1. Inspect for cracks or improper installation Fan Housing, Upper Pulley, Lower Pulley, Cooling Fan, and Air Guide Housing.. .....:		

NOTE: Belt Tension:
New Belt 31°@ 22.5 lbs
Old Belt .40°@ 22.5 lbs

ELECTRICAL SYSTEM:	MECH INTL	INSP INTL
1. Check Batteries for security, and proper external condition..........:		
2. Check terminals for any corrosion & clean if necessary..........:		
3. Inspect Battery trays for corrosion, and vent for obstruction..........:		
4. Inspect Alternators and Backlash (.90)...:		
5. Inspect electrical components & wiring....:		

FUEL SYSTEM:	MECH INTL	INSP INTL
1 Inspect fuel injection system.... ......:		
2. Check all Hoses, Tubing, Fitting, Flow Distributor, Injector Lines, and Injector Fittings ....:		
3 Replace 2 Micron Fuel Filter . ...:		
NOTE: CUT FUEL FILTER OPEN FOR INSPECTION:		
4. Remove, Clean & inspect dry-air filter.. :		
5. Inspect air induction system & alternate air valve..........:		
6. Inspect fuel selector valve for operation and proper pointer indication..........:		
7 Operate Main, Boost, & Emergency fuel pumps..........:		
8. Check pressure on all lines for leaks.. ..:		
9 Drain [illegible] fuel sump		
10 Inspect Induction Manifold for leaks and		

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AIRFRAME SECTION:
(Refer to Mooney Service & Maintenance Manual)

	MECH INTL	INSP INTL
1 Inspect exterior and interior of aircraft for general condition, collision damage, loose rivets, dents, and corrosion		
2 Inspect Tubular Structure for corrosion Per Mooney S B M20-208A :		
3 Inspect wings and empennage for general condition, collision damage, loose rivets, dents, and corrosion :		
4 Inspect control surfaces for security of attachment, proper rigging, free movement, collision damage, loose rivets, dents, and corrosion .... :		
5 Lubricate flight control system guide blocks, hinge points, rod end bearings, and bell cranks ... :		
6 Inspect all wing, fuselage, and empennage drain holes for obstruction :		
7 Inspect empennage trim system for proper operation and rigging ... :		
8 Inspect flap system for proper operation and rigging. (Lubricate in accordance with Mooney S&M Manual)........ :		
9. Inspect flight instruments for proper operation, marking, and condition........ :		
10. Inspect cabin lights, circuit breakers, and electrical components for proper operation. (Check operation of stall warning system)........ :		
11. Inspect Autopilot system for security and proper operation .... :		
12. Inspect wing interior in fuel tank area for fuel leaks, fuel tank vents for obstruction, and fuel filler caps for security and proper operation........ :		
13. Inspect cabin and baggage doors for condition, proper operation, and sealing.. :		
14. Inspect windshield and windows for cracks, crazing, scratches, and distortion. :		
15. Inspect seats, seat belts, and shoulder harnesses for security, proper operation, & condition........ :		
16. Inspect compass & compass deviation card for proper indication & compensation. :		
17. Inspect radio equipment for proper installation and operation. .... :		
18. Inspect cabin interior for proper sealing :		
19. Remove exhaust cavities, inspect area.. :		
20. Lubricate engine controls & inspect for security, full travel & free movement..... :		

LANDING GEAR OPERATION CHECK:
(Refer to Mooney S&M Manual)

	MECH INTL	INSP INTL
1 Raise aircraft on jacks. .... :		
2 Inspect brakes, hydraulic brake cylinders, & hydraulic system for leaks & general condition. (service reservoir with MIL-H-5606 (RED) fluid .... :		
3 Remove wheels, inspect, repack, reinstall, & safety. Lubricate brake guide pins using Silicone-base lubricant. Check wheels for free rotation & proper brake action :		
4 Lubricate & inspect landing gear pivot points & moving parts.... :		

ELECTRIC GEAR RETRACTION SYSTEM:

	MECH INTL	INSP INTL
1 Check operation & rigging. .... :		
2. Check warning system lights, horn, & visual indicator........ :		
3. Check air speed safety switch........ :		
4. Check doors for proper closing. .... :		
5. Check emergency system by lowering gear using emergency gear extension system :		

NOTE: Do Not attempt gear retraction using emergency system. (Refer to Mooney S&M Manual)

	MECH INTL	INSP INTL
6 Inspect shock absorbers (main & nose gears) in accordance with Mooney S&M Manual ... :		
7 Inspect wheelwell areas. .... :		

POST-INSPECTION OPERATION CHECK:
(Refer to aircraft POH)

When starting engine using the approved external power source no special starting procedure is necessary. Using normal starting procedures DO NOT start the engine when either battery is completely [illegible]

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	MECH INTL	INSP INTL
1 Check ease of operation of engine control :		
2 Check alternators (2) output indication .		
3 Check oil pressure indication .		

NOTE: If minimum oil pressure is not indicated within (5) SECONDS accomplish engine shutdown procedures:

	MECH INTL	INSP INTL
4 Check Main, Boost, and Emergency pumps for proper operation and pressure indication :		
5 Check fuel quantity indication ... :		
6 Check cylinder head temperature indication:		
7 Check oil temperature indication.. :		
8 Check idle RPM (600+/-25) ... :		
9 Check cabin & panel lights........ :		
10 Check radio operation. .... :		
12. Check Distributor RPM drop L/R...... :		
14. Check fuel selector valve operation.. ... :		
15 Flight check gear-up warning horn at 1/4" 3/8" from power lever closed........ :		
16 Flight check aircraft rigging and autopilot system for proper operation........ :		
17 Make a cabin ventilation and heating system carbon monoxide check........ :		
18. Check ELT battery and ELT system for proper operation........ :		
19. Check flap position indicator........ :		
20. Check trim position indicator........ :		

VALVE CLEARANCE CHECK
Refer to Porsche Aviation Products S&M Manual

	MECH INTL	INSP INTL
1. With engine cold: Remove all ignition leads		
2. Remove one spark plug from each cylinder .:		
3 Remove upper & lower camshaft housing cover		
4. Remove gasket from lower camshaft housing.:		
5 Check the gap between valve stem and adjustment screw on rocker arm with a dial indicator. Each cylinder should be checked in the same sequence as the firing order (1-6-2-4-3-5). Always visually check the lobes. Lifter Bodies should be on low side of the lobe if piston is at top dead center........ :		

	MECH INTL	INSP INTL
6 Starting with the number one cylinder turn the prop clockwise until both valves of the cylinder are closed and the top dead center mark on the belt pulley coincides with the line marks on the fan housing........ :		
7 Check valve clearance. (If necessary, loosen nut on the adjustment screw, correct the valve clearance by turning the adjustment screw and then while holding screwdriver, tighten the locking nut .... :		

NOTE: VALVE CLEARANCE SHOULD BE AS FOLLOWS:
INTAKE VALVE: .004" +/- .002"(.1 mm +/- .05mm)
EXHAUST VALVE: .004" +/- .002"(.1mm +/- .05mm)

	MECH INTL	INSP INTL
8 Turn propeller to the next mark (120 DEGREES) to check cylinder no.... : 6 and repeat valve clearance check........ :		
9. Repeat the above for the remaining 4 cylinders........ :		
10 Check to be sure all locking nuts are secure and replace camshaft housing gaskets and covers........ :		
11. Apply anti-seize to plug threads .... :		
12 Reinstall spark plugs (TORQUE TO 250 IN. LBS.)........ :		
13 Reinstall ignition leads being careful not to let the lead turn in the nut. (TORQUE NUT TO 110 IN. LBS.)........ :		

REMARKS--- :

CHAPTER 6 FAA REGULATIONS

Changes in the FAR'S

On August 4,1997 after 5 years in development the first of many revisions to the Federal Air Regulations was made effective.

This Chapter will review the changes made to FAR Part 61. As the FAR'S are revised the MAPASF will compile and brief you on these changes. This chapter is reserved to review current or recent changes to FAR'S, Airspace or Air Traffic Procedures affecting IFR or VFR flight.

This review is part of the requirements to be accomplished for the Bi-Annual Flight Review.

Accident Investigations

Although the National Transportation Safety Board (NTSB) has primary responsibility for aircraft accident investigations, it generally accepts the FAA's description of situations not involving Air Carriers or where no fatal injuries were sustained. Since the FAA investigates all accidents, as well as conducting the enforcement procedures for alleged FAR violations, we need to understand the rules. Part 830.2 of the NTSB regulations contains definitions of interest

"Aircraft Accident" means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the **intention of flight** and all such persons have disembarked, and in which any person suffers **death or serious injury** or in which the aircraft receives **substantial damage.**

"Fatal Injury" means any injury which results in death within 30 days of the accident.

"Incident" means an occurrence other than an accident associated with the operation of an aircraft, which affects or could affect the safety of operations.

"Operator" means any person who causes or authorizes the operation of an aircraft, such as the owner, **lessee,** or bailee of an aircraft.

"Serious Injury" means any injury which (1) requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; (2) results in a fracture of any bore (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns or any burns affecting more than five percent of the body surface.

"Substantial Damage" means damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component. Engine failure or damage limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires, flaps, engine accessories, brakes or wing tips are not considered "substantial damage" for the purpose of this Part."

The several important exceptions to the substantial damage definition mean that many occurrences are not accidents. **Most gear-up landings, taxi accidents, and minor loss of control situations often do not result in "substantial damage."** (Taxi accidents may not have occurred with the intention of flight)

WHEN AN OCCURRENCE IS NOT AN ACCIDENT, DONT REPORT AN ACCIDENT!

NTSB Part 830.5, Immediate Notification, **requires** the reporting of accidents and certain incidents:

'The operator of an aircraft shall immediately, and by the most expeditious means available, notify the nearest National Transportation Safety Board field office when:

"(A) An aircraft accident or any of the following listed incidents occur

(1) Flight control system malfunction or failure;
(2) Inability of any required flight-crew member to perform normal flight duties as a result of injury or illness
(3) Not applicable (turbine engine failures)
(4) In-flight fire; or
(5) Aircraft collide in flight
(6) Damage to property, other than the aircraft, estimated to exceed $25,000
(7) Not applicable (large multi-engine aircraft)

"(B) An aircraft is overdue and **is** believed to have been involved in an accident" **For Part 91 Mooney operators these are the only accident and incident reports required. THE REPORTING REQUIREMENT IS TO THE NTSB (usually within 10 days), NOT THE FAA.**

Aviation Safety Reporting System (by John Pallante, CFII)

The Aviation Safety Reporting System (ASRS) is operated by NASA under an agreement with the FAA and is described in FAR 91.25 and FAA Advisory Circular 00-46C- To encourage pilots and controllers to report safety problems, reports to the ASRS are confidential and the identity of the filing party cannot be revealed.

In 1985, the FAA claimed that there had been no breach of confidentiality in the 42,000 reports then filed. However, confidentiality does not make a defense when appearing in an FAA license suspension hearing.

Paragraph 9C of the Advisory Circular sets forth the defense, quite concisely, for a government regulation:

"C. The filing of a report with NASA concerning an incident or occurrence involving a violation of the Act of the Federal Aviation Regulations is considered by the FAA to be indicative of a constructive attitude. Such an attitude will tend to prevent future violations. Accordingly, although a finding of a violation may **be** made, neither a civil penalty nor certificate suspension will be imposed if:

"(1) The violation was inadvertent and not deliberate;

"(2) The violation did not involve a criminal offense, or accident, or action under Section 609 of the Act which discloses a lack of qualification or competency, which are wholly excluded from this policy;

"(3) The person has not been found in any prior FAA enforcement action to have committed a violation of the Federal Aviation Act, or of any regulation promulgated under that Act for a period of 5 years prior to the date of that occurrence; and

"(4) The person proves that, within 10 days after the violation, he or she completed and delivered or mailed a written report of the incident or occurrence to NASA under ASRS."

The ASRS form may be obtained free from FAA offices, FSSs, or directly from NASA at the ASRS office, P.O. Box 189, Moffett Field, CA 94035. ft you write to NASA for the form, ask to be put on the mailing list for CALLBACK, their monthly publication.

The filing of an ASRS form in ten days will give a immunity from enforcement action unless the pilot a used the **ARSR** syste immunity within the last **five years** or made an intentional transgressi way the system works is that the top of the form, called an Identificati n, is the only place with the reporter's name and address. Upon delivery SA it is marked with a time receipt stamp and mailed back to the author. it away for production at any subsequent investigation.

ASRS forms may be filed at any time by any pilot, passenger, or air traffic controller as many times as they choose.
The form and its immunity however can only be used once every 5 years.

Mooney
Aircraft
Pilots
Association
Safety Foundation

1. 7-6-2. AIRCRAFT ACCIDENT AND INCIDENT REPORTING {Redesignated July 20, 1995. Was 7-91.}

a. OCCURRENCES REQUIRING NOTIFICATION - The operator of an aircraft shall immediately, and by the most expeditious means available, notify the nearest National Transportation Safety Board (NTSB) Field Office when:

1. An aircraft accident or any of the following listed incidents occur

(a) Flight control system malfunction or failure;

(b) Inability of any required flight crewmember to perform their normal Sight duties as a result of injury or iliness;

(c) Failure of structural components of a turbine engine excluding compressor and turbine blades and vanes.

(d) Inflight fire;

(e) Aircraft collide in flight.

(f) Damage to property, other than to aircraft, estimated to exceed $25,000 for repair (including materials and labor) or fair market value in the event of total loss, whichever is less.

(g) For large multiengine aircraft (more than 12,500 pounds maximum certificated takeofF weight):

(1) Inflight failure electrical systems which requires the sustained use of an emergency bus powered by a backup source such as a battery, auxiliary power unit, or air driven generator to retain flight control or essential instruments;

(2) Inflight failure of hydraulic systems that results in sustained reliance on the sole remaining hydraulic or mechanical system for movement of flight control surfaces;

(3) Sustained loss of the power or thrust produced by two or more engines: and

(4) An evacuation of aircraft in which an emergency egress system is utilized.

1. An aircraft is overdue and is believed to have been involved in an accident. b. MANNER OF NOTIFICATION -

2. The most expeditious method of notification to the NTSB by the operator will be determined by the circumstances existing at that time. The NTSB has advised that any of the following would be considered examples of the type of notification that would be acceptable:

(a) Direct telephone notification.

(b) Telegraphic notification.

(c) Notification to the FAA who would in turn notify the NTSB by direct communication; that is, dispatch or telephone.

a. ITEMS TO BE NOTIFIED - The notification required above shall contain the following information, if available:

1. Type, nationality, and registration marks of the aircraft;
2. Name of owner and operator of the aircraft;
3. Name of the pilot in command,
4. Date and time of the accident, or incident;
5. Last point of departure and point of intended landing of the aircraft;
6. Position of the aircraft with reference to some easily defined geographical point;
7. Number of persons aboard, number killed, and number seriously injured;
8. 8 Nature of the accident, or incident, the weather, and the extent of damage to the aircraft, so far as is known; and
9. A description of any explosives, radio active materials, or other dangerous articles carried. d. FOLLOW-UP REPORTS:
10. The operator shall file a report on NTSB Form 6120.1 or 6120.2, available from NTSB Field Offices, or from the NTSB, Washington, D.C., 20594.

(a) Within 10 days after an accident;

(b) When, after 7 days, an overdue aircraft is still missing;

(c) A report on an incident for which notification is required as described in subparagraph a(l) shall be filed only as requested by an authorized representative of the NTSB.

1. Each crewmember, if physically able at the lime the report is submitted, shall attach a statement setting forth the facts, conditions and circumstances relating to the accident or incident as they appeared. If the crewmember is incapacitated, a statement shall be submitted as soon as physically possible-
2. e. WHERE TO FILE THE REPORTS -
3. The operator of an aircraft shall file with the NTSB Field Office nearest the accident or incident *any report* required by this section,
4. 2- The NTSB Field Offices are listed under US Government in the telephone directories in the following cities: Anchorage, AK, Atlanta, GA, Chicago, IL, Denver, CO; Fort Worth, TX; Los Angeles, CA; Miami, FL; Parsippany, NJ; Seattle, WA.

5. § 830-2 Definitions.
6. As used in this pan the following words or phrases are defined as

follows:

7. "'Aircraft accident" means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage.
8. "Civil aircraft" means any aircraft other than a public aircraft.
9. "Fatal injury" means any injury which results in death within 30 days of the accident.
10. "Incident" means an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations.
11. "Operator" means any person who causes or authorizes the operation of an aircraft, such as the owner, lessee, or bailee of an aircraft. (New-95-8 Revised Aug. 7, 1995, effective Sept. 6, 1995}
12. Public aircraft means an aircraft used only for the United States Government, or an aircraft owned and operated (except for commercial purposes) or exclusively leased for at least 90 continuous days by a government other than the United States Government, including a State, the District of Columbia, a territory or possession of the United States, or a political subdivision of that government- "Public aircraft" does not include a government-owned aircraft transporting property for commercial purposes and does not include a government-owned aircraft transporting passengers other than: transporting (for other than commercial purposes) crewmembers or other persons aboard the aircraft whose presence is required to perform, or is associated with the performance of; a governmental function such as firefighting, search and rescue, law enforcement, aeronautical research, or biological or geological resource management; or transporting (for other than commercial purposes) persons aboard the aircraft if the aircraft is operated by the Armed Forces or an intelligence agency of the United States. Notwithstanding any limitation relating to use of the aircraft for commercial purposes, an aircraft shall be considered to be a public aircraft without regard to whether it is operated by a unit of government on behalf of another unit of government pursuant to a cost reimbursement agreement, if the unit of government on whose behalf the operation is conducted certifies to the Administrator of the Federal Aviation Administration that the operation was necessary to respond to a significant and imminent threat to life or properly (including natural

resources) and that no service by a private operator was reasonably available to meet the threat.

13. (Beginning of old text revised Aug. 7, 1995}
14. "Public aircraft" means an aircraft used exclusively in the service of any government or of any political subdivision thereof including the government of any State, Territory, or possession of the United States, or the District of Columbia, but not including any government-owned aircraft engaged in carrying persons or property for commercial purposes. For purposes of this section, "used exclusively in the service or" means, for other than the Federal Government, an aircraft which is owned and operated by a government entity for other than commercial purposes or which is exclusively leased by such government entity for not less than 90 continuous days.
15. "Serious injury" means any injury which: (I) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second or third degree bums, or any bums affecting more than 5 percent of the body *surface.*
16. "Substantial damage" means damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normallv require major repair or replacement of the affected component Engine failure or damage limited to an engine if only one engine fails or is damaged, bent failings or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered "substantial damage" for the purpose of this part.
17. [As amended at 60 FR 40112, Aug. 7, 1995]
18. Subpart B • Initial Notification of Aircraft Accidents, Incidents, and Overdue Aircraft § 830.5 Immediate notification.

Mooney Aircraft Pilots Association Safety Foundation

CHAPTER 7. MOONEY ACCIDENTS

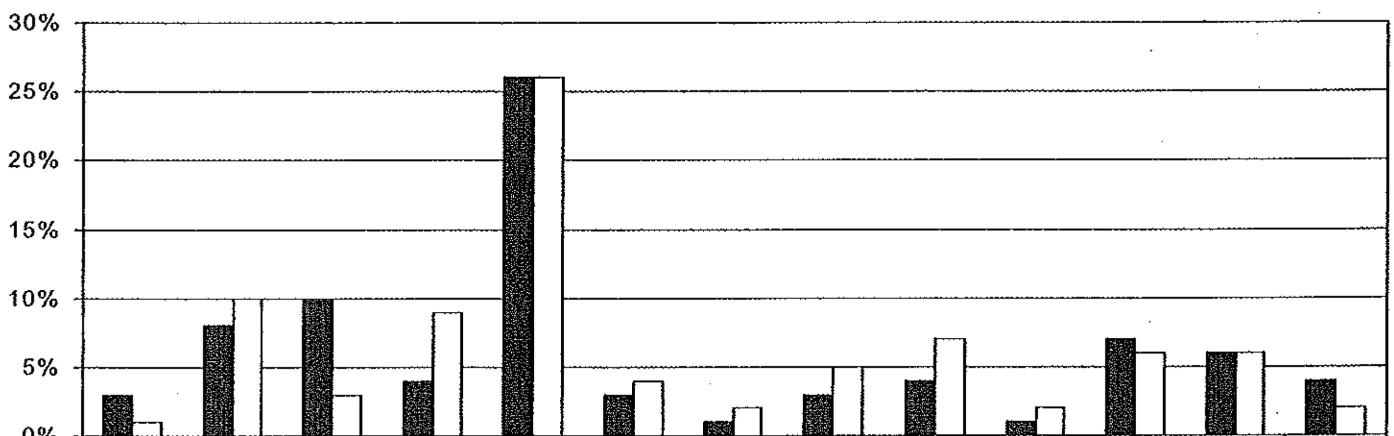
Overview - Mooney Accidents

This chapter presents an overall summary of accidents involving M20 series aircraft, followed by a review of primary accident causes, the pilot profiles unique to specific accident types, and finally, a discussion of the discrepancies or pilot actions which led to each type of accident. Special thanks to the AOPA Air Safety Foundation and NTSB for providing the data in the chapter.

Material in this chapter is based on a detailed study of 392 Mooney accidents that occurred from 1982 through 1991. National Transportation Safety Board (NTSB) findings were analyzed to determine the primary causes of these accidents and relate them to pilot experience, ratings, judgments and actions. Relevant instructional areas have been identified and incorporated into this MAPA Safety Foundation Pilot Proficiency Program.

Shown below (and page 7-2) are the primary causes and percentage distributions of the 156 accidents and 309 fatalities/serious injuries.

Mooney M20 Serious Accidents: Pilot Cause



	Preflight	TakeOff	Climb	Fuel	Weather	Cruise	Descent	VFR Appr.	IFR Appr.	Missed Appr.	Maneuver	Landing	Other
looney	3%	8%	10%	4%	26%	3%	1%	3%	4%	1%	7%	6%	4%
omp. A/C	1%	10%	3%	9%	26%	4%	2%	5%	7%	2%	6%	6%	2%

Source: AOPA Safety Foundation

Mooney Serious Accidents – Primary Cause

	Accidents		*Fatal/Serious Injuries*		*Aircraft Damage*			
					Destroyed		*Substantial*	
Cause	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**
Preflight	3%	4	1%	4	0%	0	4%	1
Takeoff/Initial Climb	8%	12	9%	27	9%	11	0%	0
Climb	10%	16	8%	25	11%	14	4%	1
Cruise - Fuel Exhaustion/Starvation	4%	6	4%	11	3%	4	8%	2
Cruise - Weather	26%	40	28%	86	31%	40	0%	0
Cruise - Other	3%	4	5%	15	2%	2	8%	2
Descent	1%	2	1%	2	2%	2	0%	0
Approach - VFR	3%	5	4%	11	2%	3	8%	2
Approach - IFR	4%	7	4%	12	5%	6	4%	1
Go-Around/Missed Approach	1%	2	1%	3	1%	1	4%	1
Maneuvering/Low Level Flight	7%	11	8%	24	9%	11	0%	0
Landing Gear Extension/Retraction	1%	2	1%	4	2%	2	0%	0
Landing - Hard	1%	2	1%	3	0%	0	8%	2
Landing - Long	1%	1	0%	1	0%	0	4%	1
Landing - Short	1%	1	0%	1	0%	0	4%	1
Landing - Other	2%	3	2%	5	1%	1	8%	2
Other Causes	4%	6	3%	8	5%	6	0%	0
Subtotal: Pilot	79%	124	78%	242	81%	103	67%	16
Powerplant/Propeller	5%	8	6%	19	6%	8	0%	0
landing Gear/Brakes/Wheel	1%	1	0%	1	0%	0	4%	1
Fuel System	2%	3	2%	6	1%	1	8%	2
Electrical/Ignition	2%	3	1%	4	1%	1	8%	2
Vacuum System/Instruments	1%	1	1%	2	1%	1	0%	0
Subtotal: Mechanical/Maintenance	10%	16	10%	32	9%	11	21%	5
Subtotal: Other/Undetermined	10%	16	11%	35	10%	13	13%	3
Grand Total: All Causes	100%	156	100%	309	100%	127	100 %	24

Note: All figures rounded to nearest %

Source: AOPA Safety Foundation

Pilot Profiles

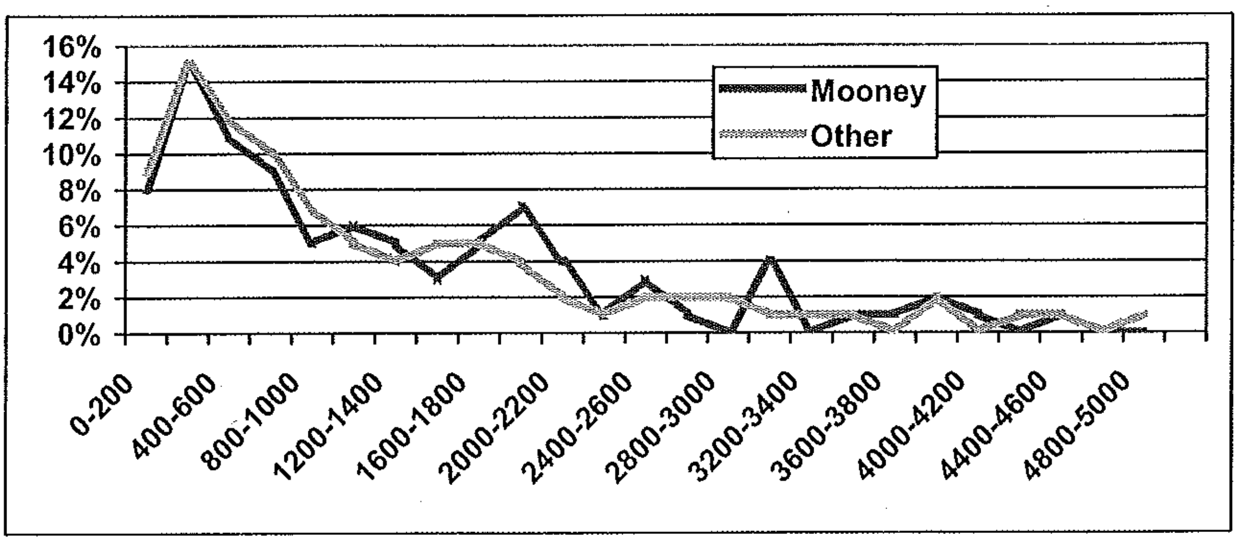
A survey of Mooney pilots conducted by Plane and Pilot (September 1990 issue) showed that the median M20 aircraft annual hours flown were 138. Median pilot total and Mooney hours logged were 1611 and 400. This is in general agreement with the following data from the FAA Office of Management Systems, showing Hours Flown vs. Accidents, and indicating that 121 hours were flown by the average Mooney.

M20 SERIES HOURS FLOWN vs. ACCIDENTS
1991

Aircraft Registered	6,463
Active Aircraft	5,861
Total Fleet Hours	709,000
Hours per Aircraft	121
Yearly Accidents (1982-1991)	35
Accidents per 1,000 Hours	0.05
Hours per Accident	20,257

Pilot Time-In-Type Serious Accidents History

Pilot experience is a powerful variable in aircraft accidents. As is true with most aircraft, both the M20 and comparative group witness fewer accidents as pilots gain experience in the particular model. Mooney places well compared to similar retractables. As shown in the graph below, the M20 has 9% fewer accidents in the first 100 hours of a pilot's time than the comparative aircraft.



Values for pilot hours by accident primary cause are presented graphically on Page 7-5. The table below shows a qualitative comparison of pilot profiles that have been correlated with various accident causes.

PRIMARY ACCIDENT CAUSE vs. PILOT PROFILE

PRIMARY CAUSE	*TOTAL TIME*	*MOONEY TIME*	*90 DAY TIME*	*%*
Adverse Weather	high	average	low	57%
Judgment	above avg.	above avg.	low	42%
Control Loss	low	low avg.	low	26%
Airspeed Mgmt	low avg.	very low	very low	40%
Gear Mgmt	average	average	low	43%
Fuel Mgmt	above avg.	average	very low	37%
Poor Preflight	average	above avg.	low	50%

Accident Data by Primary Cause

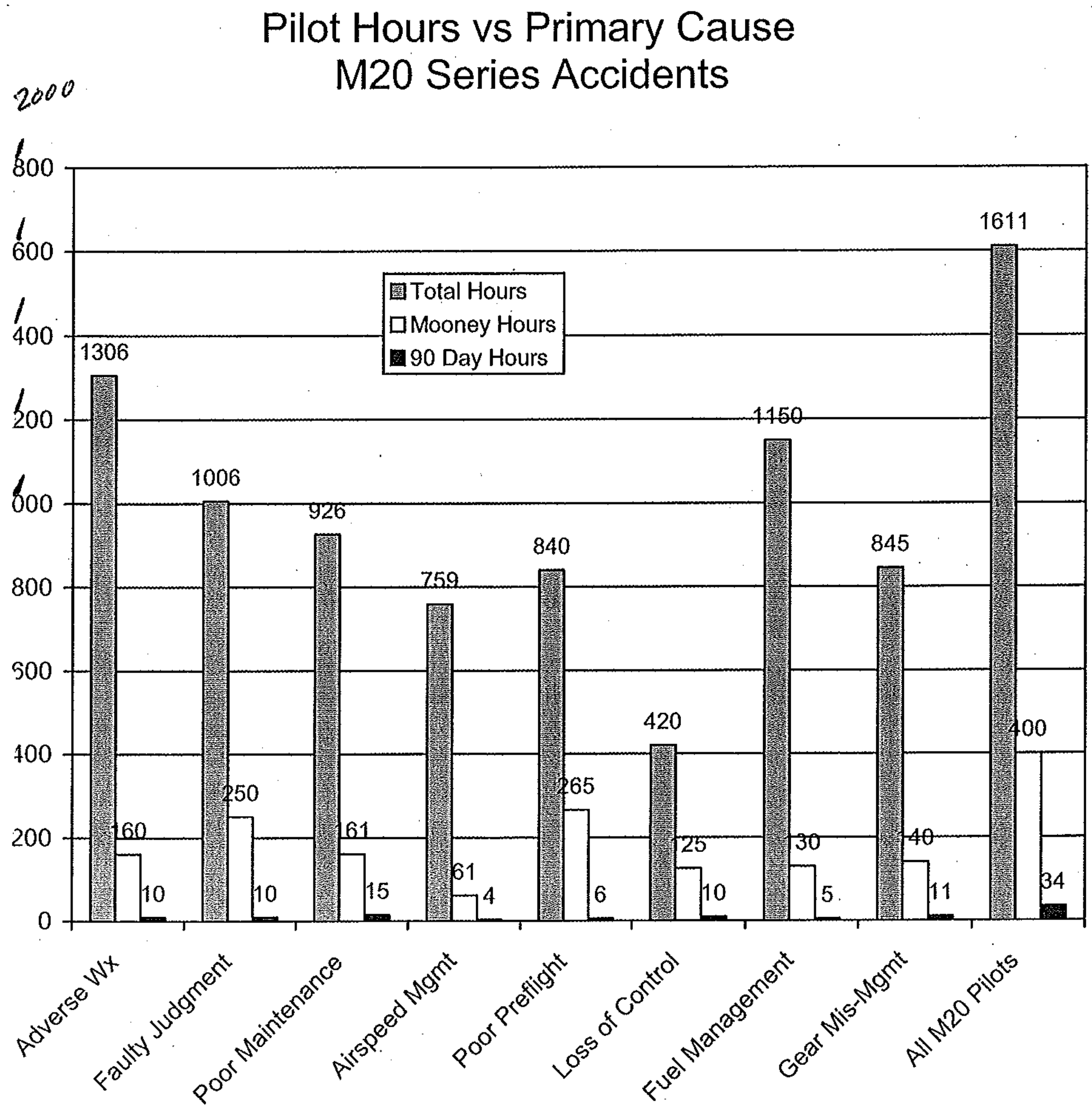
In the following sections we present discussions of each primary cause, together with the associated pilot profile as suggested by the data. At the end of this chapter, detailed summary data tables are presented for each prime cause.

Adverse Weather

- Weather and unfavorable environments (IMC/Turbulence/Night Conditions) were the leading cause of accidents and fatalities, 16% and 48% respectively. While weather is related to one sixth of the total accidents, it causes half of the fatalities. Coincidentally, the percentage of total injuries associated with weather accidents is only 8%.

- Most adverse weather accidents fall into 2 roughly equal groups: VFR rated pilots who enter instrument meteorological conditions, and IFR rated pilot indiscretions during turbulence, IFR descents and approaches. The few remaining accidents were caused by induction system, carburetor heat, and vacuum system misuse or malfunction.

- The pilot profile for adverse weather accidents is characterized by high total time, average Mooney time, low recent time, with 57% holding an instrument rating.



Source: AOPA Safety Foundation

Judgment

- Judgment applies to decisions and actions after the preflight, but not the impact of adverse weather effects. These preventable accidents accounted for 14% of the total, 18% of the fatalities and 16% of the injuries. Drugs/alcohol, low level "buzzing", improper mountain operations, and power line impact by both IFR and VFR pilots accounted for the fatalities and half the injuries. Additional injuries resulted from high density altitude operations, hand propping and downwind takeoffs.

- Pilots displaying poor judgment had above average total and Mooney times, low recent time and 52% were instrument rated.

Improper Maintenance

- Faulty engine and propeller accidents caused 45% of maintenance related accidents and 67% of fatalities. Turbocharged power plant malfunctions were major contributors to this category. Spar failure of an old wood wing model flown by its new owner with only 15 Mooney hours resulted in 4 fatalities. The remaining 55% of accidents resulted in 1 fatality and 14 injuries.

- The profile for this category shows average total and Mooney hours, but low recent time.

Loss of Control

- Control loss occurred primarily in cross-wind conditions during landing, go-around, take off or initial climb. Improper landing flare technique induced loss of control, with a resultant hard landing or porpoise. Control loss accidents were 12% of the total, causing 3% of fatalities and 13% of injuries.

- The pilot profile for loss of control situations shows low total time, lower than average Mooney time, low recent time, and only 26% were instrument rated.

Airspeed Management

- Poor airspeed management was responsible for 11% of all accidents and 5% of fatalities. Most airspeed accidents were long landings or overshoots, which caused over half of the injuries but no fatalities. Landing stalls and failure to establish a positive rate of climb accounted for all fatalities. Go-around stall accidents, generally induced by improper pitch trim, accounted for most of the remaining injuries.

- The pilot profile for airspeed accidents is distinctive: less than average total time, very low Mooney time, and low recent time. Of this pilot group 40% were IFR rated.

Gear Mismanagement

- Gear mismanagement accidents included failure to extend or verify gear down and locked, and a few premature gear retractions during takeoff. This category comprised 8% of total accidents but only 2% of fatalities. However, by conservative estimate there were at least another 250 **incidents** (involving less than substantial damage to the aircraft) of gear up landings. Somewhere in the world, a Mooney is landed with the gear retracted about once every week.

- The pilots who landed gear up had average total and Mooney hours, and low recent time. IFR ratings were held by 43% of this pilot group.

Fuel Mismanagement

- Fuel mismanagement caused 7% of total accidents and only 2% of fatalities, an apparent tribute to the emergency landing abilities of the pilots. This accident invariably involved failure to switch tanks, or running both tanks dry.

- The fuel mismanagement pilot profile shows above average total time, average Mooney time, and very low recent time. Only 37% had IFR ratings.

Improper Preflight

- Improper preflight was a direct contributor to 6% of all accidents, 4% of fatalities, and 6% of injuries. Failure to discover/correct fuel contamination is the most significant problem.

- Other preflight omissions which led to accidents include checks of fuel quantity, pitot static drains, baggage door inner latch, magnetos, and pitot covers.

- Pilots deficient during preflight had average total time, above average Mooney time, low recent time, with 50% IFR rated.

Other Causes

- This category, including midair and taxi collisions and bird/vehicle/deer strikes, was responsible for 5% of total accidents, 4% of fatalities and 4% of injuries.

- The pilot profile includes very high total time, average Mooney time, and low recent time. IFR ratings were held by 47% of the pilots involved.

Undetermined Causes

- Undetermined causes were responsible for 7% of all accidents, 6% of fatalities and 7% of injuries, and included suspected power loss, control loss, midair collision, fuel flow interruption, and gear failure.

- Accidents of undetermined causes were experienced by pilots with above average total time, average Mooney time and low recent time. Of these pilots 55% held IFR ratings.

Mooney Aircraft Pilots Association Safety Foundation

M20 SERIES ACCIDENT SUMMARY - PRIMARY CAUSE

1982 - 1991

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Adverse Weather	47	77	10	20	27
Judgment	42	27	21	20	22
Improper Maintenance	42	15	19	21	21
Loss of Control	35	5	17	26	9
Airspeed Management	31	8	13	19	12
Gear Mismanagement	23	2	7	13	10
Undetermined	20	9	10	9	11
Fuel Mismanagement	20	3	17	13	7
Improper Preflight	18	7	10	9	9
Other	16	7	7	8	7
Total All Causes	294	160	131	159	135

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	TOTAL HOURS	*TOTAL M20*	*M20 90 DAYS*
Median Pilot Hours	851	140	8

cc: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: ADVERSE WEATHER

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR*	*IFR*
VFR Rated Pilot in IMC	14	28	1	14	0
VFR Operations in IMC	12	16	6	2	10
IFR/VFR Opns, Turbulence	9	18	0	2	7
Descent Below DH/MDA	5	7	2	0	5
Climb in IMC	4	6	0	2	2
Induction System Icing	2	1	1	0	2
Vacuum Loss in IMC	1	1	0	0	1
Total All Discrepancies	47	77	10	20	27

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	1308	160	10

ırce: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: JUDGEMENT

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Unsuitable Runway	12	0	6	8	4
Drugs/Alcohol	9	14	2	4	5
Low Level Flight	5	7	2	1	4
High Density Altitude	5	0	6	2	3
Hand Starting	4	0	3	2	2
Mountain Operations	3	5	1	0	3
Approach/Power Lines	3	1	1	3	0
Closing Door	1	0	0	0	1
Total All Discrepancies	42	27	21	20	22

****

	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	1006	250	10

cc: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: IMPROPER MAINTENANCE

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Engine/Propeller	18	10	5	5	13
Wood Wing	1	4	0	1	0
Gear/Brakes	8	0	1	7	1
Fuel System	6	1	6	4	2
Oil System	6	0	5	3	3
Spark Plugs	2	0	2	0	2
Flight Controls	1	0	0	1	0
Total Discrepancies	42	15	19	21	21

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	926	161	15

urce: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: LOSS OF CONTROL

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Landing/Cross Wind	21	2	8	15	6
Take Off/Cross Wind	5	3	0	4	1
Hard Landing	8	0	5	7	1
Take Off/Autopilot	1	0	4	0	1
Total Discrepancies	35	5	17	26	9

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	420	125	10

cc: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: AIRSPEED MANAGEMENT

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Landed Long	19	0	7	11	8
Take Off/Rate of Climb	3	4	1	2	1
Landing Stall	2	4	0	1	1
Go-Around Stall	5	0	5	3	2
Take Off/Flap Retraction	2	0	0	2	0
Total All Discrepancies	31	8	13	19	12

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	759	61	4

urce: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: GEAR MISMANAGEMENT

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Extension/Check	20	2	7	12	8
Early Retraction	3	0	0	1	2
Total Discrepancies	23	2	7	13	10

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	845	140	11

cc: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: UNDETERMINED

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Power Loss ?	13	0	9	6	7
Lost Control ?	4	8	0	2	2
Midair Collision ?	1	1	0	0	1
Fuel Flow ?	1	0	1	0	1
Gear Failure ?	1	0	0	0	1
Total Discrepancies	20	9	10	9	11

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	1032	140	7

urce: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: FUEL MISMANAGEMENT

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Tank Selected/Exhausted	20	3	17	13	7
Total All Discrepancies	20	3	17	13	7

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	1150	130	5

:cc: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: IMPROPER PREFLIGHT

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR*	*IFR*
Fuel Contamination	12	5	5	6	6
Baggage Door Latch	1	2	1	0	1
Oil Quantity	1	0	4	1	0
Fuel Quantity	1	0	0	1	0
Pitot Cover Not Removed	1	0	0	1	0
Pitot Static System	1	0	0	0	1
No Magneto Check	1	0	0	0	1
Total All Discrepancies	18	7	10	9	9

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	840	265	6

Source: AOPA Safety Foundation

MOONEY ACCIDENT ANALYSIS: 1982-1991

Primary Accident Cause: OTHER

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Midair Collision	5	5	3	3	2
Unauthorized Pilot	1	1	0	0	0
Incapacitation	1	1	1	0	1
Impact by Vehicle	1	0	3	0	1
Taxi/Roll Collision	5	0	0	3	2
Passenger Interference	1	0	0	1	0
Airstrike/Bird	1	0	0	1	0
Groundstrike/Deer	1	0	0	0	1
Total Discrepancies	16	7	7	8	7

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	1930	150	8

rce: AOPA Safety Foundation

M20 SERIES ACCIDENT SUMMARY - FLIGHT PHASE

1982 - 1991

PRIMARY CAUSE	*ACCIDENTS*	*FATALITIES*	*INJURIES*	*VFR RATING*	*IFR RATING*
Landing	137	2	62	80	57
Descent	61	81	27	30	31
Takeoff	28	8	15	16	12
Approach	20	8	11	8	12
Maneuver	18	28	7	6	12
Cruise	15	24	2	11	4
Standing	5	0	4	2	3
Taxi	5	0	2	3	2
Unknown	3	6	0	2	1
Climb	2	3	1	1	1
Total All Phases	294	160	131	159	135

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	TOTAL HRS	*TOTAL M20*	*M20 90 DAY*
Median Pilot Hours	851	140	8

urce: AOPA Safety Foundation

M20 SERIES ACCIDENT BY FLIGHT PHASE

1982 – 1991

FLIGHT PHASE	*ACCIDENTS*	*% ACCIDENTS*	*FATALITIES*	*% FATALITIES*
Landing	137	46	2	1
Descent	61	21	81	51
Takeoff	28	9	8	5
Approach	20	7	8	5
Maneuver	18	6	28	17
Cruise	15	5	24	15
Standing	5	2	0	0
Taxi	5	2	0	0
Unknown	3	1	6	4
Climb	2	1	3	2
Total	**294**	**100**	**160**	**100**

Summary:

The "AOPA Safety Foundation" undertook this study. The original study contains a number of accident reports from the National Transportation Safety Board (NTSB). Since the time that this study was written the "World Wide Web" has become natural resource for data of all sorts. We would encourage pilots to use the Internet for further research on more resent accidents. In addition to NTSB reports are data from the "National Aeronautics and Space Administration" (NASA). NASA and their research staff base the data from NASA on safety issues that are reported by pilots on the NASA form and studies performed. NASA also produces a monthly safety bulletin. In the future the MAPASF will conduct a study, under a grant from the FAA, on Mooney accidents.

NTSB: http://www.ntsb.gov/Aviation
NASA: http://www.olias.arc.gov/asrs

Mooney Aircraft Pilots Association Safety Foundation

NOTES

CHAPTER 8. BY THE NUMBERS

Why fly "By the Numbers"?

Every flight is a combination of distinct segments: takeoff, initial climb, cruise-climb, cruise, enroute descent, approach level, IFR/ILS descent, IFR MDA level, missed approach, or IFR landing. Pilots who fly "By the Numbers" routinely use a **Power setting, Attitude**, and **Configuration**, or **PAC**, which yields the desired aircraft **Performance** for each flight segment. For example, when using this technique, set up the cruise-climb the same way on each flight, and you will soon know what to expect from the airplane in terms of feel and performance.

Power settings are expressed in terms of engine speed (rpm) and inches of manifold pressure (mp) or full throttle (FT). **Attitude** is stated in degrees of pitch angle, with "nose up" as positive. **Configuration** is defined by gear (up or down), and wing flap (up, takeoff, down) positions. The resulting **Performance** is the combination of indicated or true airspeed (ias, tas) expressed in miles per hour or knots (mph, kts), and vertical speed indication (vsi) in feet per minute (fpm).

There is no uniform presentation of pitch attitude information in the variety of artificial horizons found in the Mooney series. Some have no pitch reference lines other than the horizon itself; some are marked every two degrees from two to ten degrees, some are marked every five degrees, etc. Nor can we use "bar widths" as a reference, since there is no standardized airplane symbol. We will therefore refer to pitch up (+) or down (-) in degrees, leaving it to the reader to learn his own numbers and the appearance of his own artificial horizon in each flight segment

The **PAC** technique is beneficial during both VFR and IFR operations, however this section will address the heavy workload of the single pilot IFR, which is greatly facilitated when flying "by the numbers". The transition from one flight segment to the next normally requires only a single **PAC** change. Instead of setting up each segment by trail and error, the pilot establishes a predetermined **PAC**, knowing the **Performance** that will result.

We have developed **PAC**s for the stock M20C/Ranger, M20E/Super 21, M20J/201, M20K/231, M20K/252, M20M/TLS, M20R/Ovation, and Rocket & Missile models at mid weights. IFR flight segments are addressed in logical sequence, and summary **PAC** tables for the above models are included at the end of this chapter. Our purpose is not only to suggest **PAC** numbers, but to encourage and assist pilots in finding settings best suited to their own aircraft and missions. It will be apparent from the discussion how one would develop suitable numbers for other aircraft.

Takeoff and Initial Climb

We are concerned here with normal takeoff operations under reasonably good conditions. We will have completed all pre-flight planning, run a thorough check list, and made a well founded Go/No-Go decision for the mission.

All takeoffs should be executed using **maximum available power** and liftoff airspeeds as given in the POH, followed by acceleration to or slightly above best rate of climb speed (Vy). M20K/231 PACs are for stock models; for 231s with intercoolers, always refer to the supplemental POH data for that particular aircraft.

The gear is raised when no useable runway remains, and the aircraft stabilized in a full power Vy climb to at least 1000 ft agl. In manual gear aircraft, the airspeed profile should be such that gear retraction can be accomplished before the airspeed exceeds 80 mph.

The initial climb segment is an optimum performance maneuver, limited by available power. Flying and trimming for the proper airspeed thus becomes the important pilot action in attaining a satisfactory rate of climb.

INITIAL CLIMB PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: 2700 mp: FT	+8°	flaps: up gear: up	ias: 105 mph vsi:+800 fpm
M20E/F	rpm: 2700 mp: FT	+8°	flaps: up gear: up	ias: 105 mph vsi:+800 fpm
M20J (201)	rpm: 2700 mp: FT	+8°	flaps: up gear: up	ias: 90 kts vsi:+900 fpm
M20K (231)	rpm: 2700 mp: 40"	+8°	flaps: up gear: up	ias: 90 kts vsi:+900 fpm
M20K (252)	rpm: 2700 mp: 36"	+8°	flaps: up gear: up	ias: 90 kts vsi:+900 fpm
M20M (TLS)	rpm: 2575 mp: FT	+8°	flaps: up gear: up	ias: 105 kts vsi:+1100fpm
M20R (OVA)	rpm: 2500 mp: FT	+8°	flaps: up gear: up	ias: 105 kts vsi:+1000fpm

Cruise Climb

The transition from initial climb to a cruise climb requires only a reduction in pitch attitude and retrimming for a better visibility higher speed climb, followed by a power reduction (never below 1000 ft agl) to the POH recommended power.

Climb at POH power levels, since engine cooling is dependent upon both the recommended fuel flow and airspeed. While climbing, always monitor engine, cylinder and exhaust temperatures for operation "in the green".

Normally aspirated engines and earlier turbocharged engines require frequent power setting checks under the changing atmospheric conditions which accompany climbs to higher altitudes. With some newer models, cowl flaps may be partially closed after acceleration to cruise climb airspeeds, and in the Ovation there are no cowl flaps.

The cruise climb is also an optimum performance maneuver, requiring use of the proper airspeed, combined with the lowest possible drag configuration which will yield sufficient engine cooling.

CRUISE CLIMB PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: 2600 mp: 26"	+4°	flaps: up gear: up	ias: 115 mph vsi:+700 fpm
M20E/F	rpm: 2500 mp: 25"	+4°	flaps: up gear: up	ias: 120 mph vsi:+700 fpm
M20J (201)	rpm: 2600 mp: 26"	+4°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
M20K (231)	rpm: 2600 mp: 33"	+4°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
M20K (252)	rpm: 2500 mp: 32"	+4°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
M20M (TLS)	rpm: 2400 mp: 34"	+4°	flaps: up gear; up	ias: 130 kts vsi:+1000fpm
M20R (OVA)	rpm: 2500 mp: FT	+4°	flaps: up gear: up	ias: 120 kts vsi:+900 fpm

Cruise

In making the transition from climb to cruise, lower the nose enough to maintain altitude, close cowl flaps (if applicable, engine temperatures permitting), accelerate to cruise airspeed, ***then*** set cruise power using the **KEY NUMBER.** Indicated airspeed is a function of weight and power, while true airspeed is a function of density altitude. Most properly maintained aircraft should true out at or above the speeds shown in the **CRUISE PAC** chart below.

NOTE: Set your attitude indicator to zero in level flight cruise for your sitting height.

At 4,000' msl or higher, most normally aspirated Mooneys will cruise most efficiently with the throttle full open, with no obstructions in the induction air path. All that remains is for you to set the RPM that will equal the **KEY NUMBER** (**46** for the M20C,E,F, or **47** for the M20J/201/205/MSE @ **65%,** with ± **3** equaling ± **10%**) for your desired % of power. This means that if you level off at 6,000'msl in your M20J, and you desire **65% power**, and you have 24"mp at full throttle; then you should set 2300rpm to equal your **KEY NUMBER** of **47**. The lower the RPM the lower the fuel consumption, and noise, and wear and tear on your engine. The engine should then be leaned with the aid of an EGT (exhaust gas temperature) gauge for best economy (25° F rich of peak egt) or best power (100° F rich of peak egt).It can take up to five minutes after level off for the EGT to stabilize. True airspeed is about four knots less in economy cruise versus best power cruise. The RPM listed in the **CRUISE PAC** below is the maximum one should use and represents CRUISE CLIMB RPM for normally aspirated models, and 75% power for the turbocharged models.

Operators of turbocharged models should refer to POH tables to develop their own KEY NUMBER (**52** in the M20K/231 @ **65%,** with ± **4** equaling ± **10%**). Thus I can set 2200rpm with 30"mp and get 65%, or I can set 2500rpm with 27"mp and still get **52**, my KEY NUMBER for 65%. The difference is I save ½ gal/hr. at the lower rpm. In addition, that is 18,000 less times the spark plugs had to fire, and 72,000/108,000 (4cyl./6cyl.) less explosions I have to cool off in one hour. An understanding of the effects of fuel flow on engine power and cooling at various altitudes is important in selecting proper mixture. In KEY NUMBER computations, one inch manifold pressure equals 100 rpm.

Cruise is an optimum performance flight segment. We are in cruise the majority of our flight time, and has the most effect on overall performance. The task is to obtain the best possible fuel economy consistent with desired airspeed, engine cooling, and consider the impact of noise and vibration on creature comfort. Any power setting that causes a vibration in your engine, should not be used. Operation of engine RPM in the yellow arc for prolonged periods is to be avoided always.

CRUISE PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: 2600 mp: FT	0°	flaps: up gear: up	tas: 160+mph vsi: 0 fpm
M20E/F	rpm: 2500 mp: FT	0°	flaps: up gear: up	tas: 165+mph vsi: 0 fpm
M20J 201	rpm: 2600 mp: FT	0°	flaps: up gear: up	tas: 157+kts vsi: 0 fpm
M20K 231	rpm: 2400 mp: 33"	0°	flaps: up gear: up	tas: 160+kts vsi: 0 fpm
M20K 252	rpm: 2500 mp: 29"	0°	flaps: up gear: up	tas: 170+kts vsi: 0 fpm
M20M TLS	rpm: 2400 mp: 32"	0°	flaps: up gear: up	tas: 190+kts vsi: 0 fpm
M20R OVA	rpm: 2300 mp: 23.6"	0°	flaps: up gear: up	tas: 175+kts vsi: 0 fpm

KEY NUMBERS

The addition of inches of manifold pressure to hundreds of rpm = % of cruise power

MODEL	75%	65%	55%		TAS knots			FUEL gal/hr	
M20C	49	**46**	43	145	**140**	135	8.5	**8.0**	7.5
M20E/F	48	**45**	42	150	**145**	140	9.5	**9.0**	8.5
M20J 201	50	**47**	44	160	**155**	150	9.5	**9.0**	8.5
M20K 231	56	**52**	48	165	**160**	155	12.1	**10.8**	9.4
M20K 252	53	**49**	45	175	**170**	165	13.0	**11.0**	9.5
M20M TLS	58	**54**	50	195	**190**	185	18.0	**16.0**	14.0
M20R OVA	46.5	**44**	41.5	175	**165**	155	14.5	**12.8**	11.1

Enroute Descent

A well planned descent can "buy back" much of the fuel used in the climb, along with pleasing airspeeds, fuel economy and improved engine life. Reduce power by decreasing engine RPM to the minimum recommended by the engine manufacturer or permitted by the POH. Maintain cruise MP during the descent, with reductions to no less than 55% BHP for normally aspirated engines, and 25" to 30" for turbo-charged models.

Note: Lean mixture to maintain EGT 25°F degrees rich of peak.

Allow 2 minutes/1000' of altitude that you have to lose to give 500'/min. descent, which is a comfortable rate in unpressurized aircraft. The "Oversquare" power settings discussed here are described in applicable engine manuals. The low rpm puts back pressure on the pistons, and prevents piston ring float. By maintaining high EGT, we prevent shock cooling and spark plug fouling. Speed brakes with higher power settings can be useful during expedited descents to prevent excessive engine cooling and airspeeds in the yellow arc.

ENROUTE DESCENT PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: 2300 mp: 20"	-3°	flaps: up gear: up	ias: 150+mph vsi: -500 fpm
M20E/F	rpm: 2350 mp: 19"	-3°	flaps: up gear: up	ias: 160+mph vsi: -500 fpm
M20J (201)	rpm: 2200 mp: 22"	-3°	flaps: up gear: up	ias: 150+kts vsi: -500 fpm
M20K (231)	rpm: 2000 mp: 30"	-3°	flaps: up gear: up	ias: 155+kts vsi: -500 fpm
M20K (252)	rpm: 2000 mp: 25"	-3°	flaps: up gear: up	ias: 155+kts vsi: -500 fpm
M20M (TLS)	rpm: 2000 mp: 25"	-3°	flaps: up gear; up	ias: 160+kts vsi: -500 fpm
M20R (OVA)	rpm: 2000 mp: 22"	-3°	flaps: up gear: up	ias: 160+kts vsi: -500fpm

APPROACH LEVEL/HOLDING

The transition from cruise-descent to approach level or holding requires only setting a holding power setting and retrimming to maintain altitude. The cruise rpm combined with 18"mp for normally aspirated engines, or 25" mp for turbocharged engines should yield about 105 kias (120 mph), except for the large engine aircraft. Adjust mp to maintain airspeed, a change of 1"mp affects airspeed about five knots. Keep the engine leaned to 25 degrees rich of peak inorder to save fuel, especially if holding.

The **Approach Level/Holding PAC** combine low noise levels, with low fuel consumption, and reduced pilot workload for the more critical approach segment following. Complete the setup of radios and nav equipment for the approach, and then during the final turn out of holding or procedure turn inbound start the final GUMPS (Gas, Undercarriage, Mixture, Prop, Seatbelts/shoulder harness) check. Use of this PAC will help us stay ahead of the airplane during the period of highest pilot workload: a tight approach in Low IFR.

APPROACH LEVEL/HOLDING PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: 2300 mp: 18"	+3°	flaps: up gear: down	ias: 120 mph vsi: 0 fpm
M20E/F	rpm: 2350 mp: 18"	+3°	flaps: up gear: down	ias: 120 mph vsi: 0 fpm
M20J (201)	rpm: 2200 mp: 18"	+3°	flaps: up gear: down	ias: 105 kts vsi: 0 fpm
M20K (231)	rpm: 2200 mp: 25"	+3°	flaps: up gear: down	ias: 105 kts vsi: 0 fpm
M20K (252)	rpm: 2200 mp: 25"	+3°	flaps: up gear: down	ias: 105 kts vsi: 0 fpm
M20M (TLS)	rpm: 2200 mp: 25"	+3°	flaps: up gear: down	ias: 120 kts vsi: 0 fpm
M20R (OVA)	rpm: 2200 mp: 18"	+3°	flaps: up gear: down	ias: 115 kts vsi: 0 fpm

IFR/ILS DESCENT

Perhaps the simplest PAC is the IFR/ILS descent, which requires only that we lower the gear at glide slope intercept or the non precision FAF. This will result in a 500 fpm descent at the same airspeed with little change to either power or trim. With an approach level speed of 105 kts, one can initiate a 500'/min descent just by dropping the landing gear and maintain 105 kts, pitch attitude will be about 3 degrees nose down. However, if your runway is short, you must consider that you have to slow to 70 - 75 kts for landing. This procedure is for aircraft at a high traffic airports with long runways.

Otherwise your approach speed is going to be 90 kts The landing gear should be extended about 2 miles prior to the FAF, or when the glide slope is halfway down. Then passing the FAF, or intercepting the glide slope reduce manifold pressure five inches, which starts a 500'/min. descent at 90 kts, the pitch attitude will be almost level. *Each inch of mp equals 100'/min*: so adjusting glide slope is just a matter of adjusting mp. Adding approach flaps decreases airspeed by about 7 kts, and can be equalized by adding 1"mp. Adding 5"mp will cause the aircraft to level off for any intermediate step down fix.

To simplify the IFR missed approach, our ILS descent PAC does not call for the use of wing flaps until the runway is in sight and the decision to land is made. When putting in full flaps, trim to maintain the almost level pitch attitude, and the airplane will slow to 70 - 75kts crossing the fence and settle at 500 fpm.

IFR/ILS DESCENT PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: 2300 mp: 18" mp: 13"	-3° 0°	flaps: up gear: down	ias: 120 mph vsi: 500 fpm ias: 105 mph
M20E/F	rpm: 2350 mp: 18" mp: 13"	-3° 0°	flaps: up gear: down	ias: 120 mph vsi: 500 fpm ias: 105 mph
M20J (201)	rpm: 2200 mp: 18" mp: 13"	-3° 0°	flaps: up gear: down	ias: 105 kts vsi: 500 fpm ias: 90 kts
M20K (231)	rpm: 2200 mp: 25" mp: 20"	-3° 0°	flaps: up gear: down	ias: 105 kts vsi: 500 fpm ias: 90 kts
M20K (252)	rpm: 2200 mp: 25" mp: 20"	-3° 0°	flaps: up gear: down	ias: 105 kts vsi: 500 fpm ias: 90 kts
M20M (TLS)	rpm: 2200 mp: 25" mp: 20"	-3° 0°	flaps: up gear: down	ias: 120 kts vsi: 500 fpm ias: 100 kts
M20R (OVA)	rpm: 2200 mp: 18" mp: 13"	-3° 0°	flaps: up gear: down	ias: 115 kts vsi: 500 fpm ias: 90 kts

IFR/MDA Level

Unless the operating minima in FAR 91.175(c) are met, we may descend no lower than the Minimum Descent Altitude (MDA) or Decision Height (DH), and we will generally continue for some distance in level flight, especially if a circle to land maneuver is required. On a circle to land, further descent is not initiated until on base leg of the selected runway.

Depending on how the descent was initiated will determine the method of leveling off. If the landing gear was used to cause the descent at 105 knots, then we will just change the pitch attitude from -3 to +3 degrees and allow the airspeed to bleed off to 90 knots. Those aircraft making the 90 knot approach by reducing power 5 inches, level off just by adding 5" mp back to the 18" or 25" mp they started with at 100' above the MDA until the Missed Approach Point (MAP) is passed, or the flight continues VFR.

If the runway environment cannot be positively identified, we must begin the missed approach at the MAP, or DH. Prepare for the missed approach by memorizing at least the initial heading and altitude, and have the propeller set for climb power.

IFR/MDA LEVEL PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: 2300 mp: 18"	+3°	flaps: up gear: down	ias: 105 mph vsi: 0 fpm
M20E/F	rpm: 2350 mp: 18"	+3°	flaps: up gear: down	ias: 105 mph vsi: 0 fpm
M20J (201)	rpm: 2200 mp: 18"	+3°	flaps: up gear: down	ias: 90 kts vsi: 0 fpm
M20K (231)	rpm: 2200 mp: 25"	+3°	flaps: up gear: down	ias: 90 kts vsi: 0 fpm
M20K (252)	rpm: 2200 mp: 25"	+3°	flaps: up gear: down	ias: 90 kts vsi: 0 fpm
M20M (TLS)	rpm: 2200 mp: 25"	+3°	flaps: up gear: down	ias 105 kts vsi: 0 fpm
M20R (OVA)	rpm: 2200 mp: 18"	+3°	flaps: up gear: down	ias: 105 kts vsi: 0 fpm

Missed Approach

When ceiling or visibility are below minimums, the missed approach can be the most critical IFR flight phase, and should be performed without distraction or increase in the already high pilot workload. In contrast to the VFR go-around, we have ample airspeed as we initiate the IFR missed approach segment. The task here is to arrest any descent and transition to a initial climb PAC at essentially the same airspeed.

Implement the missed approach PAC by setting climb power, raising the wing flaps if extended, establish a positive rate of climb and retract the gear, retrim as required and adjust cowl flaps if necessary.

Remember the essentials; establish climb power, retract flaps, bring the pitch attitude up 8 degrees, when a positive rate of climb is established *then* retract the gear, and fly the proper missed approach procedure.

Note: Use "check ride discipline" and initiate a missed approach any time we have full needle deflection to develop proper habits and maintain safety of flight.

MISSED APPROACH PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: 2600 mp: 26"	+8°	flaps: up gear: uo	ias: 115 mph vsi:+700 fpm
M20E/F	rpm: 2500 mp: 25"	+8°	flaps: up gear: up	ias: 120 mph vsi:+700 fpm
M20J (201)	rpm: 2600 mp: 26"	+8°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
M20K (231)	rpm: 2600 mp: 33"	+8°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
M20K (252)	rpm: 2500 mp: 32"	+8°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
M20M (TLS)	rpm: 2400 mp: 34"	+8°	flaps: up gear: up	ias: 130 kts vsi:+1000fpm
M20R (OVA)	rpm: 2500 mp: FT	+8°	flaps: up gear: up	ias: 110 kts vsi:+900 fpm

IFR Landing

The final approach PAC transition is made only after positive identification of the runway or runway environment. Slowing and reconfiguring the aircraft for landing is a crucial pilot activity and must be practiced regularly. As an exercise, occasionally carry 105 knots down to decision height, and then execute the landing. ILS equipped runways will normally be long enough for landing even with partial or no flaps if necessary. Remember, we must slow to 70 to 75 knots for landing the Mooney with full flaps. The transition is much easier from the 90 knot approach, just maintain level flight attitude and trim as flaps are extended.

If executing a circling approach, power should be 18"mp(normally aspirated) or 25"mp(turbocharged), pitch attitude +3 degrees, and aircraft slowed to 90 knots. Descent is not initiated, and flaps are not extended until on base leg in a position for a normal landing. If visual contact is lost, execute the Missed Approach PAC. In a straight-in approach, extend flaps, and trim to maintain a level pitch attitude to attain 70 - 75 kts, 500'/min descent till single story height. *Then close throttle*, and hold the nose off to a +6 degree pitch.

IFR LANDING PAC

Model	Power	Attitude	Configuration	Performance
M20C	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 80 mph vsi:-200 fpm
M20E/F	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 80 mph vsi:-200 fpm
M20J (201)	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 71 kts vsi:-200 fpm
M20K (231)	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 75 kts vsi:-200 fpm
M20K (252)	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 75 kts vsi:-200 fpm
M20M (TLS)	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 80 kts vsi:-200 fpm
M20R (OVA)	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 80 kts vsi:-200 fpm

Summary

We are convinced that "By the Numbers" techniques make good pilots even better. Tailor these PAC's for your airplane, use them consistently in your flying, and you will be amazed at how smoothly you can keep the needles centered while IMC, and the amount of time you have to look for traffic VMC.

M20C/RANGER
"IFR BY THE NUMBERS"

Power + **Attitude** + **Configuration** = **Performance**

Flight Phase	Power	Attitude	Configuration	Performance
INITIAL CLIMB	rpm: 2700 mp: FT	+8°	flaps: up gear: up	ias: 105 mph vsi:+800 fpm
CRUISE CLIMB	rpm: 2600 mp: 26"	+4°	flaps: up gear: up	ias: 115 mph vsi:+700 fpm
CRUISE	rpm: Key # mp: FT	+0°	flaps: up gear: up	tas:155+mph vsi: 0 fpm
ENROUTE DS.	rpm: 2300 mp: 20"	-3°	flaps: up gear: up	ias:150+mph vsi:-500 fpm
APPR LEVEL	rpm: 2300 mp: 18"	+3°	flaps: up gear: up	ias: 120 mph vsi: 0 fpm
IFR/ILS DS	rpm: 2300 mp: 18" mp: 13"	-3° -0°	flaps: up gear: down	ias: 120 mph vsi:-500 fpm ias: 105 mph
IFR/MDA LEVEL	rpm: 2300 mp: 18"	+3°	flaps: up gear: down	ias: 105 mph vsi: 0 fpm
MISSED APPR	rpm: 2600 mp: 26"	+8°	flaps: up gear: up	ias: 115 mph vsi:+700 fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 80 mph vsi:-200 fpm

M20E/SUPER 21
"IFR BY THE NUMBERS"

Power + Attitude + Configuration = Performance

Flight Phase	**Power**	**Attitude**	**Configuration**	**Performance**
INITIAL CLIMB	rpm: 2700 mp: FT	+8°	flaps: up gear: up	ias: 105 mph vsi:+800 fpm
CRUISE CLIMB	rpm: 2500 mp: 25"	+4°	flaps: up gear: up	ias: 120 mph vsi:+700 fpm
CRUISE	rpm: Key # mp: FT	+0°	flaps: up gear: up	tas:160+mph vsi: 0 fpm
ENROUTE DS.	rpm: 2350 mp: 20"	-3°	flaps: up gear: up	ias:160+mph vsi:-500 fpm
APPR LEVEL	rpm: 2350 mp: 18"	+3°	flaps: up gear: up	ias: 120 mph vsi: 0 fpm
IFR/ILS DS	rpm: 2350 mp: 18" mp: 13"	-3° -0°	flaps: up gear: down	ias: 120 mph vsi:-500 fpm ias: 105 mph
IFR/MDA LEVEL	rpm: 2350 mp: 18"	+3°	flaps: up gear: down	ias: 105 mph vsi: 0 fpm
MISSED APPR	rpm: 2500 mp: 25"	+8°	flaps: up gear: up	ias: 105 mph vsi:+700 fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 80 mph vsi:-200 fpm

M20J/201, 205, & MSE
"IFR BY THE NUMBERS"

Power + Attitude + Configuration = Performance

Flight Phase	Power	Attitude	Configuration	Performance
INITIAL CLIMB	rpm: 2700 mp: FT	+8°	flaps: up gear: up	ias: 90 kts vsi:+900 fpm
CRUISE CLIMB	rpm: 2600 mp: 26"	+4°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
CRUISE	rpm: Key # mp: FT	+0°	flaps: up gear: up	tas: 157+kts vsi: 0 fpm
ENROUTE DS.	rpm: 2200 mp: 22"	-3°	flaps: up gear: up	ias: 160+kts vsi:-500 fpm
APPR LEVEL	rpm: 2200 mp: 18"	+3°	flaps: up gear: up	ias: 105 kts vsi: 0 fpm
IFR/ILS DS	rpm: 2200 mp: 18" mp: 13"	-3° -0°	flaps: up gear: down	ias: 105 kts vsi:-500 fpm ias: 90 kts
IFR/MDA LEVEL	rpm: 2200 mp: 18"	+3°	flaps: up gear: down	ias: 90 kts vsi: 0 fpm
MISSED APPR	rpm: 2600 mp: 26"	+8°	flaps: up gear: up	ias: 90 kts vsi:+800 fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 71 kts vsi:-200 fpm

M20J/201, 205 MISSILE
"IFR BY THE NUMBERS"

Power + Attitude + Configuration = Performance

Flight Phase	Power	Attitude	Configuration	Performance
INITIAL CLIMB	rpm: 2650 mp: FT	+8°	flaps: up gear: up	ias: 96 kts vsi:+1400fpm
CRUISE CLIMB	rpm: 2550 mp: 25"	+4°	flaps: up gear: up	ias: 115 kts vsi:+1000fpm
CRUISE	rpm: Key # mp: FT	+0°	flaps: up gear: up	tas: 185 kts vsi: 0 fpm
ENROUTE DS.	rpm: 2200 mp: 22"	-3°	flaps: up gear: up	ias: 185+kts vsi:-500 fpm
APPR LEVEL	rpm: 2200 mp: 18"	+3°	flaps: up gear: up	ias: 120 kts vsi: 0 fpm
IFR/ILS DS	rpm: 2200 mp: 13"	-3°	flaps: up gear: down	ias: 105 kts vsi:-500 fpm
IFR/MDA LEVEL	rpm: 2200 mp: 18"	+3°	flaps: up gear: down	ias: 105 kts vsi: 0 fpm
MISSED APPR	rpm: 2550 mp: 25"	+8°	flaps: up gear: up	ias: 105 kts vsi:+1000fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 77 kts vsi:-200 fpm

M20K/231
"IFR BY THE NUMBERS"

Power + Attitude + Configuration = Performance

Flight Phase	Power	Attitude	Configuration	Performance
INITIAL CLIMB	rpm: 2700 mp: 40"	+8°	flaps: up gear: up	ias: 90 kts vsi:+900 fpm
CRUISE CLIMB	rpm: 2600 mp: 33"	+4°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
CRUISE	rpm: 2200 mp: 30"	+0°	flaps: up gear: up	tas: 160+kts vsi: 0 fpm
ENROUTE DS.	rpm: 2000 mp: 30"	-3°	flaps: up gear: up	ias: 160+kts vsi:-500 fpm
APPR LEVEL	rpm: 2000 mp: 25"	+3°	flaps: up gear: up	ias: 105 kts vsi: 0 fpm
IFR/ILS DS	rpm: 2000 mp: 25" mp: 20"	-3° -0°	flaps: up gear: down	ias: 105 kts vsi:-500 fpm ias: 90 kts
IFR/MDA LEVEL	rpm: 2000 mp: 25"	+3°	flaps: up gear: down	ias: 90 kts vsi: 0 fpm
MISSED APPR	rpm: 2600 mp: 33"	+8°	flaps: up gear: up	ias: 90 kts vsi:+800 fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 75 kts vsi:-200 fpm

M20K/231, 252 & ROCKET
"IFR BY THE NUMBERS"

<u>Power</u> + <u>Attitude</u> + <u>Configuration</u> = <u>Performance</u>

Flight Phase	Power	Attitude	Configuration	Performance
INITIAL CLIMB	rpm: 2650 mp: 38"	+8°	flaps: up gear: up	ias: 107 kts vsi:+1600fpm
CRUISE CLIMB	rpm: 2500 mp: 35"	+4°	flaps: up gear: up	ias: 130 kts vsi:+1200fpm
CRUISE	rpm: 2400 mp: 32"	+0°	flaps: up gear: up	tas: 200+ kts vsi: 0 fpm
ENROUTE DS.	rpm: 2200 mp: 25"	-3°	flaps: up gear: up	ias: 180+kts vsi:-500 fpm
APPR LEVEL	rpm: 2200 mp: 20"	+3°	flaps: up gear: up	ias: 120 kts vsi: 0 fpm
IFR/ILS DS	rpm: 2200 mp: 15"	-3°	flaps: up gear: down	ias: 105 kts vsi:-500 fpm
IFR/MDA LEVEL	rpm: 2200 mp: 20"	+3°	flaps: up gear: down	ias: 105 kts vsi: 0 fpm
MISSED APPR	rpm: 2500 mp: 35"	+8°	flaps: up gear: up	ias: 107 kts vsi:+1500fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 80 kts vsi:-200 fpm

Short field- 1.3 Vso -5Kts
-when landing if full stall as soon as wheels touch- the nose will slam down due to heavy engine weight. B/c pivot point changes.

M20K/252

"IFR BY THE NUMBERS"

Power + Attitude + Configuration = Performance

Flight Phase	Power	Attitude	Configuration	Performance
INITIAL CLIMB	rpm: 2700 mp: 36"	+8°	flaps: up gear: up	ias: 90 kts vsi:+900 fpm
CRUISE CLIMB	rpm: 2500 mp: 32"	+4°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
CRUISE	rpm: 2200 mp: 30"	+0°	flaps: up gear: up	tas: 170+kts vsi: 0 fpm
ENROUTE DS.	rpm: 2200 mp: 30"	-3°	flaps: up gear: up	ias: 160+kts vsi:-500 fpm
APPR LEVEL	rpm: 2200 mp: 25"	+3°	flaps: up gear: up	ias: 105 kts vsi: 0 fpm
IFR/ILS DS	rpm: 2200 mp: 25" mp: 20"	-3° -0°	flaps: up gear: down	ias: 105 kts vsi:-500 fpm ias: 90 kts
IFR/MDA LEVEL	rpm: 2200 mp: 25"	+3°	flaps: up gear: down	ias: 90 kts vsi: 0 fpm
MISSED APPR	rpm: 2500 mp: 32"	+8°	flaps: up gear: up	ias: 105 kts vsi:+800 fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 75 kts vsi:-200 fpm

M20M/TLS
"IFR BY THE NUMBERS"

Power + **Attitude** + **Configuration** = **Performance**

Flight Phase	Power	Attitude	Configuration	Performance
INITIAL CLIMB	rpm: 2575 mp: FT	+8°	flaps: up gear: up	ias: 105 kts vsi:+1100fpm
CRUISE CLIMB	rpm: 2400 mp: 34"	+4°	flaps: up gear: up	ias: 130 kts vsi:+1000fpm
CRUISE	rpm: 2200 mp: 32"	+0°	flaps: up gear: up	tas: 190+ kts vsi: 0 fpm
ENROUTE DS.	rpm: 2000 mp: 30"	-3°	flaps: up gear: up	ias: 165+kts vsi:-500 fpm
APPR LEVEL	rpm: 2000 mp: 25"	+3°	flaps: up gear: up	ias: 120 kts vsi: 0 fpm
IFR/ILS DS	rpm: 2000 mp: 20"	-3°	flaps: up gear: down	ias: 105 kts vsi:-500 fpm
IFR/MDA LEVEL	rpm: 2000 mp: 25"	+3°	flaps: up gear: down	ias: 105 kts vsi: 0 fpm
MISSED APPR	rpm: 2400 mp: 34"	+8°	flaps: up gear: up	ias: 130 kts vsi:+1000fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 80 kts vsi:-200 fpm

M20R/OVATION
"IFR BY THE NUMBERS"

Power + Attitude + Configuration = Performance

Flight Phase	Power	Attitude	Configuration	Performance
INITIAL CLIMB	rpm: 2500 mp: FT	+8°	flaps: up gear: up	ias: 115 kts vsi:+1100fpm
CRUISE CLIMB	rpm: 2500 mp: FT	+4°	flaps: up gear: up	ias: 130 kts vsi:+800 fpm
CRUISE	rpm: 2300 mp: 21.5"	+0°	flaps: up gear: up	tas: 165+kts vsi: 0 fpm
ENROUTE DS.	rpm: 2000 mp: 23"	-3°	flaps: up gear: up	ias: 180+kts vsi:-500 fpm
APPR LEVEL	rpm: 2200 mp: 18"	+3°	flaps: up gear: up	ias: 120 kts vsi: 0 fpm
IFR/ILS DS	rpm: 2200 mp: 18" mp: 13"	-3° -0°	flaps: up gear: down	ias: 120 kts vsi:-500 fpm ias: 105 kts
IFR/MDA LEVEL	rpm: 2200 mp: 18"	+3°	flaps: up gear: down	ias: 105 kts vsi: 0 fpm
MISSED APPR	rpm: 2500 mp: FT	+8°	flaps: up gear: up	ias: 110 kts vsi:+500 fpm
IFR LANDING	rpm: high mp: as reqd	+6°	flaps: down gear: down	ias: 75 kts vsi:-200 fpm

M20J/201 - CRUISE & RANGE at ECONOMY CRUISE (25° F rich)

RPM	MSL	2000'	4000'	6000'	8000'	10000'	12000'
				24.1"	23.0"	21.1"	19.6'
2600	use 22 to 2400rpm			**167k**	**168k**	**164k**	**162k**
		below		10.5g	10.1g	9.4g	8.9g
				24.2"	22.9"	21.0"	19.6"
2500	use 22 to 2400rpm			**164k**	**164k**	**163k**	**159k**
		below		10.1g	9.6g	9.0g	8.6g
		26.8"	26.2"	24.4"	22.8"	21.0"	19.6"
2400		**161k**	**163k**	**162k**	**161k**	**159k**	**156k**
		10.3g	10.2g	9.7g	9.1g	8.6g	8.2g
		26.1"	25.3"	24.0"	22.4"	21.0"	
2300		**156k**	**157k**	**157k**	**156k**	**154k**	
		9.5g	9.4g	9.0g	8.5g	8.0g	
		25.4"	24.4"	23.6"	22.0"	21.0"	
2200		**152k**	**152k**	**153k**	**150k**	**148k**	
		8.7g	8.5g	8.3g	7.8g	7.4g	

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QUICK POWER SETTINGS - M20J * TYPICAL AIRSPEEDS - M20J

RPM	75%	65%	55%
2600	24"	21"	18"
2500	25"	22"	19"
2400	26"	23"	20"
2300	-	24"	21"
KEY #	**50**	**47**	**44**

ALT	75%	65%	55%
2000	161	153	142
4000	164	155	144
6000	167	157	148
8000	171	161	150
10000	-	164	154

NOTES

CHAPTER 9. EMERGENCY PROCEDURES

While it would be impossible to discuss all possible Mooney emergencies, this chapter addresses the more common emergency situations, and certain others which deserve special attention due to their severity. Emergencies may be mitigated by learning and practicing recovery procedures so that the solution becomes another familiar series of actions.

Engine Fire

The seriousness of an engine fire, although infrequent, demands that a course of action be well in mind. It is unlikely that there would be enough time to "work out" a solution after the fire started. If a fire should occur while the aircraft is on the ground, immediately perform the following actions in the order listed:

1. Fuel selector valve - OFF.

2. Mixture - IDLE CUT-OFF.

3. ALL MAIN SWITCHES - OFF (Battery, Alternator/Generator, Magneto).

4. EXIT THE AIRPLANE promptly.

5. USE FIRE EXTINGUISHER TO extinguish fire.

A fire in flight is also an uncommon occurrence, but a well thought out plan is even more essential. Here again, these actions are arranged by priority and following the listed sequence is imperative.

WARNING

IN THE EVENT OF AN ENGINE FIRE IN FLIGHT, IT IS MANDATORY THAT THE PUSH TO CLOSE CABIN AIR CONTROL BE ACTUATED AT ONCE TO SHUT ALL HEATING SYSTEM OPENINGS IN THE FIREWALL. THIS WILL HELP PREVENT ENTRY OF SMOKE AND FUMES INTO THE CABIN AND POSSIBLE DISABLEMENT OF PILOT AND PASSENGERS. DO NOT ATTEMPT AN ENGINE RESTART, BUT INITIATE THE FOLLOWING ENGINE FIRE EMERGENCYPROCEDURE AT ONCE:

Engine fire emergency procedure:

1. Cabin Air control - PUSH TO CLOSE.

2. Mixture - IDLE CUT OFF.

3. Fuel selector valve - OFF.

4. Battery, Alternator/Generator and Magneto Switches - OFF (landing gear extension to be accomplished manually if required).

WARNING

DO NOT ATTEMPT AN ENGINE RESTART - INITIATE EMERGENCY LANDING PROCEDURE AT ONCE (see page 9-3).

Electrical Fire

With more installed avionics and other electrically powered equipment in our Mooneys, the possibility of electrical fires has increased. In the event of an electrical fire, there is an excellent chance that the problem can be diagnosed and isolated quickly, and the airplane landed safely. Other equipment in the airplane may then be used while the plane is being flown to the nearest airport for repairs.

Follow the procedure below to stop the fire and isolate the problem source:

1. Master switch - OFF.

2. All other electrical switches except the magneto switches - OFF.

3. Circuit breakers - CHECK TO SEE IF ANY BREAKERS HAVE POPPED OUT. If one or more has popped or tripped, leave the equipment protected by that circuit breaker OFF. Then proceed to step 4.

4. Master Switch - ON (Pause long enough after activating any electrical circuit to be sure that the smoke or other indication of fire has not

restarted).

5. ONE SWITCH AT A TIME - restore only the essential electrical components to service in order of their priority, with the sole objective of getting the airplane to a safe landing. Be sure to pause long enough to assure yourself that the most recently activated circuit is not the source of the fire.

6. After the necessary components are reactivated, leave all non-essential equipment switches OFF and proceed to a safe landing.

7. Even if the source of the problem is determined to be in one of the "essential" components, LEAVE THAT COMPONENT OFF, and proceed the best way possible to a safe landing.

Emergency Landing

The following procedure for emergency landing in the event of a power loss includes the necessary items to ensure the safest possible landing. The sequence of these steps is also important, i.e., fly the airplane first, and try to diagnose the problem only after a safe emergency landing approach has been initiated. We recommend memorizing both the **highlighted content and sequence** of this emergency landing procedure:

1. Establish and trim for **MAXIMUM GLIDE SPEED.**

2. Determine the **WIND DIRECTION.**

3. Select a **SUITABLE LANDING AREA.**

4. Establish an **ASSURED METHOD** of getting to the selected landing site.

5. Try to **DETERMINE THE REASON** for the emergency.
    a. **FUEL SELECTOR** - fullest tank.
    b. **MIXTURE CONTROL** - full rich.
    c. **AUXILIARY FUEL PUMP** - ON (if no fuel pressure, then OFF if no improvement).
    d. **MAGNETO CHECK** left and right, and leave in position for best running engine if there is a difference.
    e. **ALTERNATE AIR SUPPLY** - ON.

6. Try for a **RESTART.**

7. If restart fails, **LAND SLOWLY INTO THE WIND, SWITCHES OFF**, i.e., fuel selector, magnetos, battery, alternator/ generator (Battery or Master switch may be turned ON if landing lights are needed for a night landing).

8. **RADIO POSITION** if time permits on frequency in use, to nearest facility, or on frequency 121.5. Turn on ELT remote switch. Set Transponder to 7700.

Amplified Emergency Landing Procedure

1. The optimum glide speed is published in the Pilot's Operating Handbook or Owner's Manual for each model, and must be learned.

2. Wind direction may be determined in several ways. Always try to be aware of general weather conditions on the surface. Failing this, monitor a nearby ATIS or UNICOM, or call FSS, ATC, or the nearest tower. Observation of ground features will often show the wind direction: waves on a body of water, smoke from a chimney or other fire, flags on a pole, wash on a clothesline, or even cows in a field facing away from the wind.

3. In selecting an emergency landing site, choose the smoothest surface possible with sufficient length into the wind. An unobstructed approach without trees, power lines, buildings, fences, etc. is best, but approach planning must take such objects into account. The landing surface determines the gear up/down decision. The landing gear is the strongest aircraft structure, is specifically designed to absorb the energy of landing, and should be extended in most emergency landing situations. There are some instances when extending the landing gear is ill advised, such as landing in water, in tree tops, or on a known soft surface.

4. A no-power approach leaves little room for error. With no chance to go around, our planning and execution must consider all factors so as to guarantee making the selected landing site. Plan the approach so that

there will be plenty of altitude, using wing flaps and slips to lose altitude after the landing is assured. NEVER turn away from or lose sight of the selected landing site! Circle over the approach end of the field or make "S" turns on final approach, but do not allow the approach end of the landing area to get out of sight at any time.

5. When the safest landing area possible has been chosen and the approach initiated, try to diagnose the problem that created the emergency. If the problem can be identified and rectified, perhaps the emergency landing can be avoided.

6. Trying for a restart represents the best way to handle an emergency, i.e., to fly out of it.

7. Landing at the slowest possible ground speed includes taking maximum advantage of any available head wind and the use of full wing flaps for the touchdown. The slower the speed at touchdown, the less chance there is for damage or injury.

8. A radio position report is the last item because it has the least effect in assuring the safest possible landing. If steps 1 through 7 are well executed, time will almost certainly be available to use the radio.

Maximum Glide

The Mooney has an excellent glide ratio, with a no-wind glide distance of approximately 2.0 nautical miles (2.3 statute miles) per 1000 feet of altitude loss. To achieve this performance, the appropriate airspeed, found in the Pilot Operating Handbook or Owner's Manual, must be flown.

The following procedure should be used:

1. Landing Gear - UP

2. Flaps - UP

3. Cowl Flaps - CLOSED

4. Propeller Pitch - PULL FOR LOW RPM (feather on Rocket &

Missile)

5. Airspeed - AS SPECIFIED in Pilot Operating Handbook Manual

NOTE
AIRSPEED CONTROL IS CRITICAL TO ACHIEVING OPTIMUM GLIDE PERFORMANCE.

Emergency Descent Procedure

Later model POHs discuss two emergency descent techniques, which are applicable to all Mooneys. The first is a low power, clean configuration descent at V_{ne} (never exceed speed), which should be utilized only in smooth air. With the gear and flaps retracted and cowl flaps closed, maximum rates of descent of 2000 feet per minute or greater can be attained.

The second method consists of a low power, gear extended descent at V_{le} (maximum gear extended speed), and is suitable for conditions of light to moderate turbulence. With the gear extended, wing flaps retracted and cowl flaps closed, approximately the same 2000 feet per minute maximum rate of descent is attainable, but less horizontal distance will be traveled. In more turbulent weather, airspeeds not exceeding V_a (maneuvering speed) should be used.

For aircraft equipped with speed brakes, both of the above emergency descent methods may be used, with generally the same limiting airspeeds. Slightly higher power settings can minimize engine cooling, and greater descent rates will result.

The following procedure should be used:

1. Power - RETARD INITIALLY

2. Airspeed - at or slightly less than V_{le}

3. Landing gear - EXTEND

4. Wing Flaps - UP

5. Cowl Flaps - CLOSED

6. Power during descent - As required to MAINTAIN CYLINDER HEAD TEMPERATURE. A lower engine rpm with higher manifold pressure will give higher engine temperatures for a given power level.

NOTE

WING FLAPS SHOULD NOT BE LOWERED DURING EMERGENCY DESCENTS.

Unlatched Cabin Door

Although not so common as in some other aircraft, one so-called "emergency" is the opening of an improperly secured cabin door. Quotation marks are used here because this does not constitute a true emergency. The Mooney (and most general aviation aircraft) can be flown and landed normally with the door ajar. Problems arise when a distracted pilot tries to latch the door while airborne, to land after the landing gear has been retracted or with insufficient runway remaining.

A door opening during a training session take-off will demonstrate the proper method of coping with an inadvertent passenger door opening. Turn up the volume on the radio, fly a nominal traffic pattern, complete the landing checklist, and land the airplane. After clearing the active runway, latch the door and take-off again.

WARNING

DO NOT TRY TO LATCH THE DOOR ON THE RUNWAY OR IN THE AIR!

Unlatched Baggage Door

A potentially serious emergency is the inadvertent opening of the baggage door during take off or in flight. A Mooney can be flown normally with an open baggage door. The danger lies in the door separating at its hinge and striking the empennage. Keep the airspeed down, fly the airplane in a deliberate traffic pattern and land at the closest suitable airport.

After clearing the runway, stop and check the door for damage. If none is found, close and lock the door, complete a thorough pre-take off check and depart.

M20J and later Mooneys are equipped with baggage doors which can be opened from within, even when the door has been locked externally with the key. These doors can be used as emergency exits by removing the pin in the operating mechanism (from inside the baggage compartment), pulling the handle open, and pushing the door out at the bottom.

Manual Landing Gear Extension

Unfortunately, a large percentage of Mooney pilots have never practiced a manual gear extension. The procedure is simple enough, but it does require a division of the pilot's attention, and care to maintain airspeed, altitude and heading during the cranking operation. An excellent plan is for the pilot to perform a manual extension as part of the annual inspection while the airplane is supported on jacks.

As when using the Johnson bar manual gear on earlier models, reduce the airspeed to approximately 90 to 100 knots before starting to crank. Much less effort will be required to extend the gear at slower airspeeds. Trim the airplane for the desired airspeed, and as the gear begins to extend, retrim every few turns/pulls of the handle for a safer and easier operation.

WARNING

BE SURE TO STOW THE CRANK/HANDLE AFTER THE GEAR IS FULLY EXTENDED. FAILURE TO DO SO MAY RESULT IN DAMAGE TO THE MECHANISM, OR SERIOUS AND PAINFUL INJURY IF HANDS OR FEET SHOULD BE STRUCK BY THE ENGAGED CRANK WHILE THE GEAR IS OPERATED BY THE MOTOR.

DO NOT ATTEMPT TO RETRACT THE GEAR MANUALLY. IF THE GEAR FAILS TO RETRACT, LEAVE THE GEAR DOWN AND FLY THE PLANE TO A REPAIR FACILITY.

The manual extension procedure should be practiced both VFR and IFR:

1. REDUCE AIRSPEED to 90 to 100 knots (100-115 MPH).

2. Pull the LANDING GEAR MOTOR CIRCUIT BREAKER.

3. Place landing gear switch handle in the DOWN position.

4. LATCH FORWARD, RED LEVER BACK (Earlier models pull RED BUTTON and turn crank handle to engage manual extension mechanism), slowly pull/turn handle to lower the gear to the DOWN AND LOCKED position until the GEAR DOWN light comes ON and resistance is felt. Continuing to pull on the handle after definite resistance is felt can bind the system such that electrical retraction may not be possible.

5. Visually check GEAR DOWN INDICATOR alignment by viewing from directly above.

NOTE

THE MANUAL EXTENSION SYSTEM IS DESIGNED ONLY FOR LOWERING THE GEAR. DO NOT ATTEMPT TO RETRACT THE GEAR MANUALLY.

6. If electrical system is operational, check landing gear position lights and warning horn (landing gear relay circuit breaker must be engaged). If installed, a RAM AIR indicator light can also confirm that the gear is down.

7. In earlier models disengage the handcrank handle by stowing it along the cranking shaft. In later models, RED LEVER FORWARD INTO LATCHED POSITION. ALWAYS KEEP THE HANDLE STOWED WHEN NOT ACTUALLY IN USE.

NOTE

AFTER THE GEAR HAS BEEN MANUALLY LOWERED IN AN ACTUAL EMERGENCY, DO NOT MOVE ANY LANDING GEAR CONTROLS OR RESET ANY SWITCHES OR CIRCUIT BREAKERS UNTIL THE AIRPLANE HAS BEEN TAKEN TO A REPAIR

FACILITY AND PLACED ON JACKS. IF THE ACTUAL FAILURE WAS IN THE RETRACTION CIRCUIT THE GEAR COULD RETRACT INADVERTENTLY.

The following procedure is to be followed when retracting landing Gear After Practice Manual Extension:

1. Check to be sure HANDLE is STOWED.

2. Verify that LANDING GEAR SWITCH HANDLE is in the DOWN position.

3. ENGAGE LANDING GEAR MOTOR CIRCUIT BREAKER.

4. Place LANDING GEAR SWITCH HANDLE in the UP position.

5. Verify proper "IN TRANSIT" and "GEAR UP" indications.

Emergency Landing With Gear Retracted

If manually extending the gear is impossible and a gear up landing is unavoidable, choose a spot on a paved runway or firm sod. Make a normal approach, remembering that the plane will float farther without the aerodynamic drag of extended landing gear.

When landing is assured:

1. Throttle - CLOSED.

2. Mixture - IDLE CUT-OFF.

3. Battery, Alternator/Generator, Magneto Switches - OFF.

4. Fuel selector valve - OFF.

5. Keep wings level and make a full stall landing.

6. Get all occupants clear of the airplane as soon as possible after it has come to a complete stop.

Propeller Overspeed

All Mooneys are equipped with hydraulically controlled, constant speed propellers. An overspeed condition with this system requires immediate action, particularly if the cause is oil pressure related. A power reduction and retrimming for best rate of climb airspeed will help prevent further engine/propeller overspeed. It is then back to basics, using power for altitude control, and pitch for airspeed control. This technique will provide a safe operating envelope for the mandatory immediate diversion to the nearest airport.

The following procedure should be initiated at once:

1. Retard throttle to keep the propeller speed below red line.

2. Reduce airspeed and stabilize at best rate of climb speed.

3. Check oil pressure.

WARNING!

IF LOSS OF OIL PRESSURE IS THE CAUSE OF OVERSPEED, THE ENGINE WILL SEIZE IN A VERY SHORT TIME.

4. If oil pressure has been lost, INITIATE EMERGENCY LANDING PROCEDURE AT ONCE.

Emergency Speed Reduction

Several situations may indicate the need for an emergency airspeed reduction. If disorientation has occurred under instrument conditions or due to the effects of turbulence, landing gear deployment will increase drag, minimize airspeed build up, and provide additional stability. Should it be necessary to have the landing gear extended above V_{le} (maximum landing gear extension speed), a mandatory inspection of the landing gear and doors must be performed before further operation.

Starter Energized WARNING LIGHT Illuminated

If the starter relay fails and the Bendix pinion gear remains engaged, the STARTER ENERGIZED warning light (present on later models) will remain illuminated. Continuing to supply electrical power to the starter will eventually result
in the loss of electrical power.

The following procedure must be followed:

1. Battery, Alternator and Magneto Switches - ALL OFF

2. If on the ground, do not take-off until situation has been remedied or repaired.

3. If in flight (after an air start), land as soon as practical.

Generator Failure

The generators installed on most Mooneys with Lycoming engines are belt driven. If a generator fails, the ammeter will indicate a discharge representative of the electrical load which has been assumed by the battery. Other symptoms are a gradual decrease in performance of electrical accessories in the airplane.

When a generator failure is detected, all non-essential electrical loads should be turned off at once. The generator failure has transferred the entire electrical load (except engine operation) to the battery. To conserve the remaining battery power for necessary operations at the time of landing, the smallest possible electrical drain must be established to conserve battery power as long as possible.

A frequent scan of the engine and electrical system instruments will help in early failure detection and improve the chances of avoiding a total electrical loss. Planning ahead can help to save enough battery power for radio use and gear extension for the landing.

Alternator Failure

An inoperative alternator will place the entire electrical load (except engine operation) on the battery. Many alternator equipped airplanes have panel mounted ALTERNATOR FAILURE warning lights which will indicate a failure either when the output of the alternator is nearly zero or when an overvoltage condition exists.

Interpretation of the ammeter reading can help determine the type of alternator failure. An early indication or verification of an alternator failure to charge is best seen by a discharge reading on the ammeter. An overvoltage condition would be indicated by a higher than normal charging rate for an extended period.

The alternators installed on the Teledyne-Continental TSIO-360 series engine are gear driven. This means that the nature of the alternator problem should be diagnosed as soon as possible. If a drive gear failure has occurred, continued flight operation will risk serious engine damage.

Alternator Warning Light Illuminated

1. Verify nature of alternator failure with the ammeter - a discharge will indicate a loss of alternator output, and a higher than normal charge indication will show an overvoltage situation.

NOTE

IF THE AMMETER READING IS NORMAL, A MALFUNCTION IN THE WARNING LIGHT CIRCUITRY IS LIKELY, AND THE ALTERNATOR SHOULD BE LEFT ON.

2. If the ammeter shows a discharge, turn the alternator switch OFF. If the warning light does not stay illuminated, the alternator switch should be replaced in the ON position.

3. If the warning light remains illuminated, leave the alternator switch in the OFF position.

4. Turn all non-essential electrical equipment OFF to conserve battery power for the landing. The landing should be made as soon as practical so as to minimize any possible engine damage.

Induction System Icing

If the alternate air source for the induction system becomes frozen in the closed position, the handle located on the sub panel should be pulled. On the K Models the annunciator light will remain on as long as the handle has been pulled. On E, F, and J Models the alternate air door will open automatically, if induction icing occurs and the aircraft has been serviced properly.

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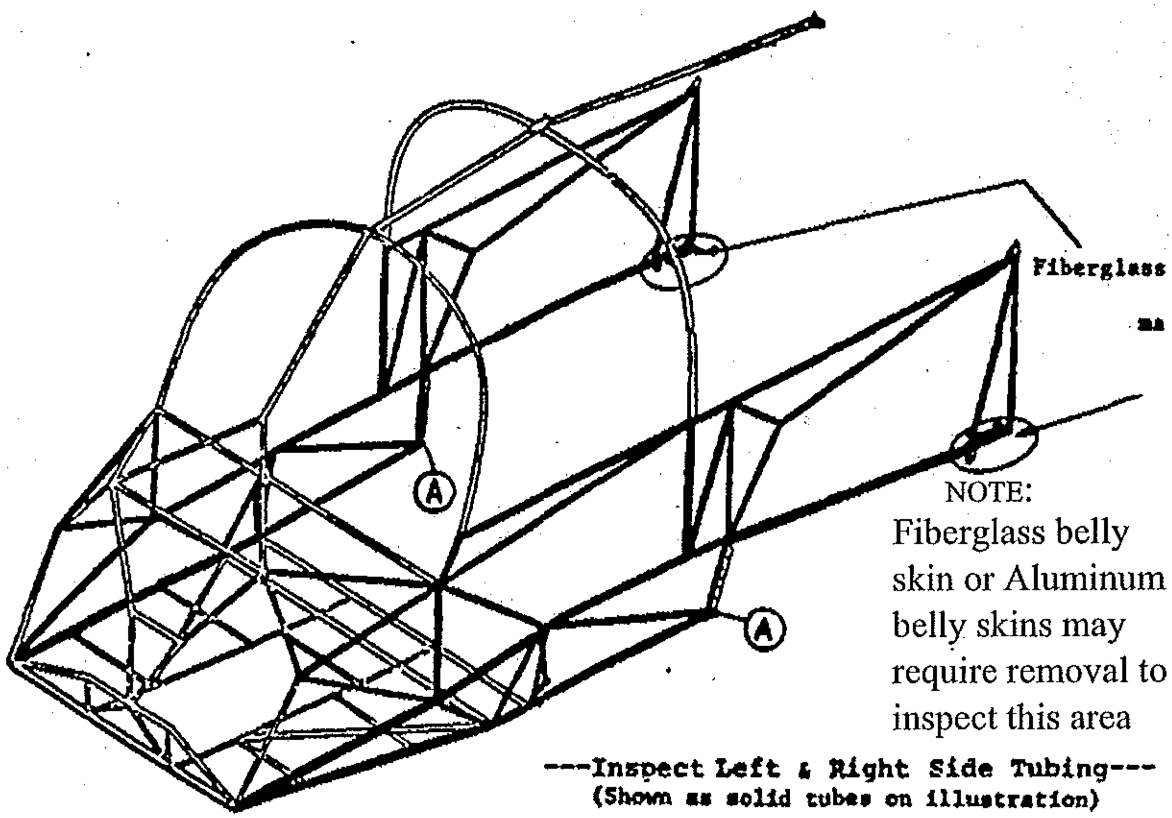
CHAPTER 10.

MOONEY AIRCRAFT SYSTEMS

General Description

M20 series aircraft are four-place high-performance single-engine low-wing monoplanes. The all-metal airframe has a tubular-steel cabin frame covered with nonstructural aluminum skins, a semi-monocoque aft fuselage, and a full-cantilever laminar-flow wing.



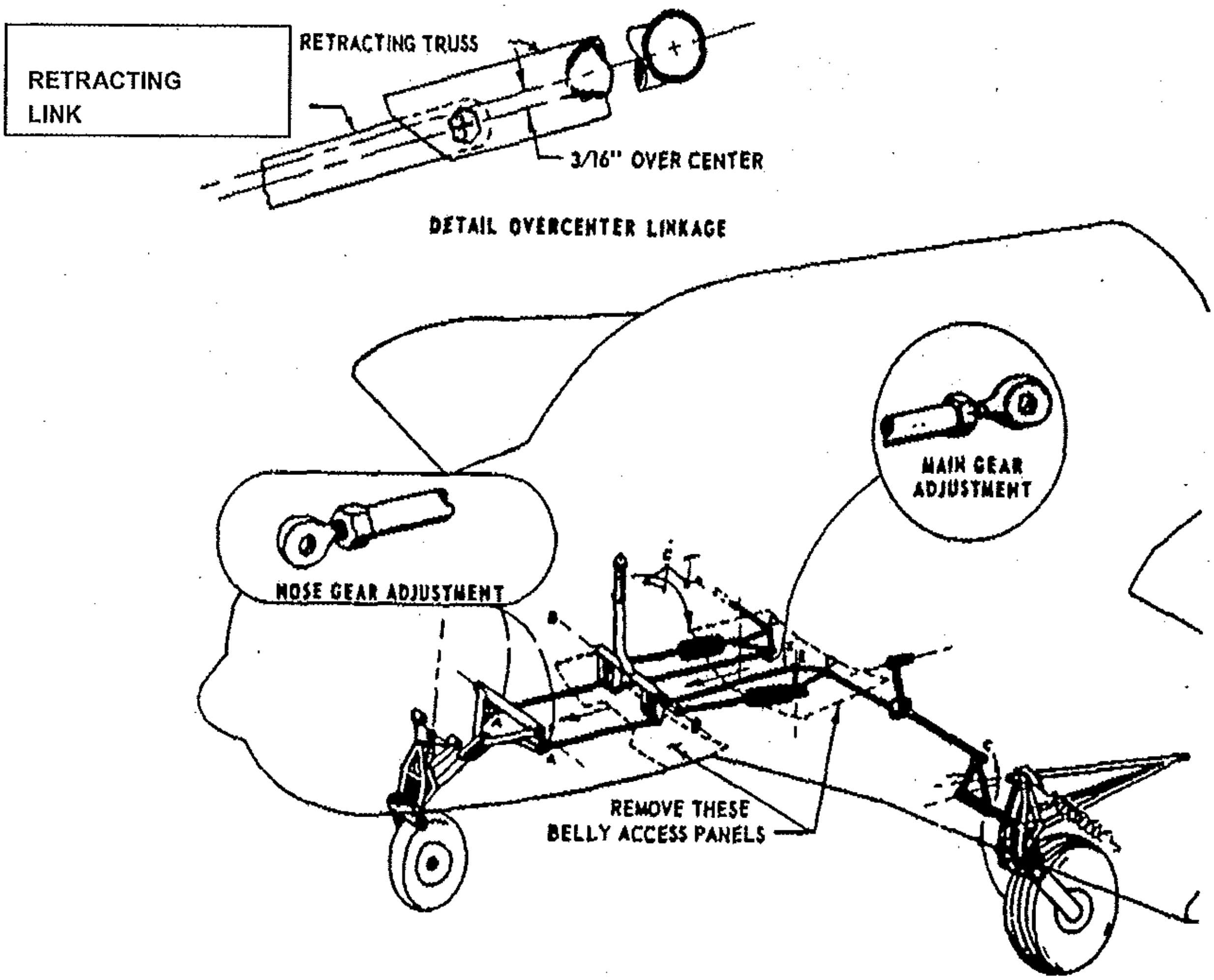
M20 Series Tubular Cabin Frame

Control surfaces have extruded-spar construction with stressed skins riveted to the spars and ribs. Dual control wheels accompany the conventional flight controls. The pilot's rudder pedals have toe brakes linked to individual hydraulic cylinders that supply pressure to the hydraulic disc brakes on each main gear wheel. Removable co-pilot rudder pedals are standard equipment

The tricycle landing gear, with steerable nose wheel controlled by rudder pedal action, is fully retractable. Wide-span trailing edge wing flaps are hydraulically actuated on models through 1968. All 1969 and later models have electrically operated wing flaps. For stabilizer trim, the entire empennage pivots around its attaching points.

Landing Gear System

The standard landing gear in all models through 1968 is manually operated. 1969 and later models are electrically operated. Optional electrical gear was available from 1965 to 1968. The gear legs are constructed of chrome-molybdenum tubular steel trusses, heat-treated for greater strength and wear resistance.



Rubber discs in the gear leg assemblies absorb the shock of taxiing and landing. Main gear attaching points have metal bushings imbedded in the gear mounting box on the wing spar.

Both the manual and electric landing gear systems have a steerable nose wheel. The nose gear steering system consists of a steering horn on the gear leg linked to the rudder pedals by push-pull tubes and bellcranks. Gear retraction automatically disengages the steering mechanism from the nose wheel and a centering cam aligns the nose wheel for entry into the wheel well.

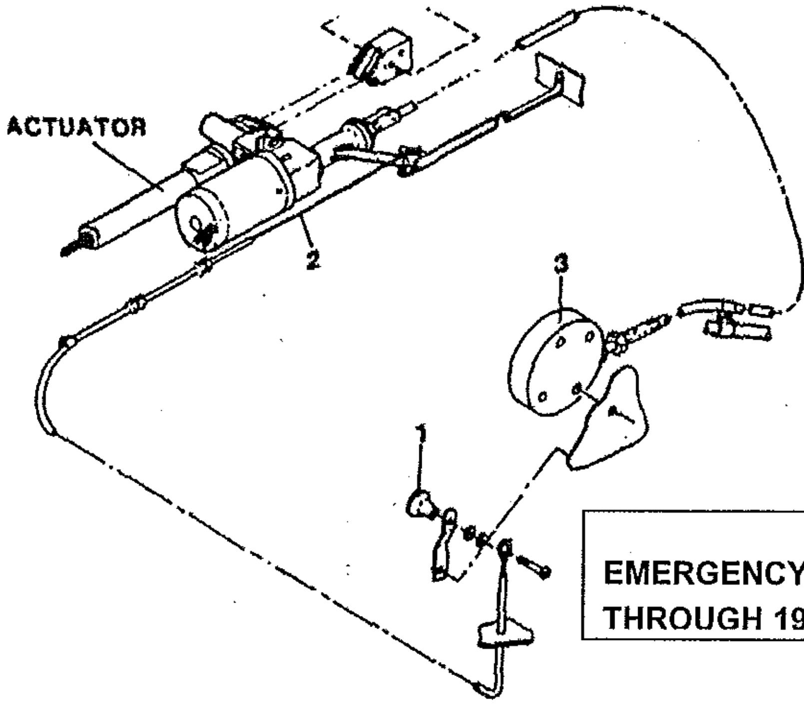
The electric gear retraction system has an emergency manual extension system connected to the gear actuator to permit manual lowering of the gear in the event of an electrical malfunction. Mooney used two different systems (see page 10-4) with essentially similar operation from the cockpit. Consult your POH for the system installed in your aircraft. Use of either manual extension system is summarized below:

1. Pull the landing gear actuator circuit breaker.
2. Move landing gear control switch to DOWN position.
3. Unlatch manual extension handle.
4. Crank or pull manual extension handle until green GEAR DOWN indicator light comes ON and/or the lines on the visual gear position indicator on the floor aft of the console are aligned when viewed from directly above the indicator. See the illustrations on page 10-4 for your system.

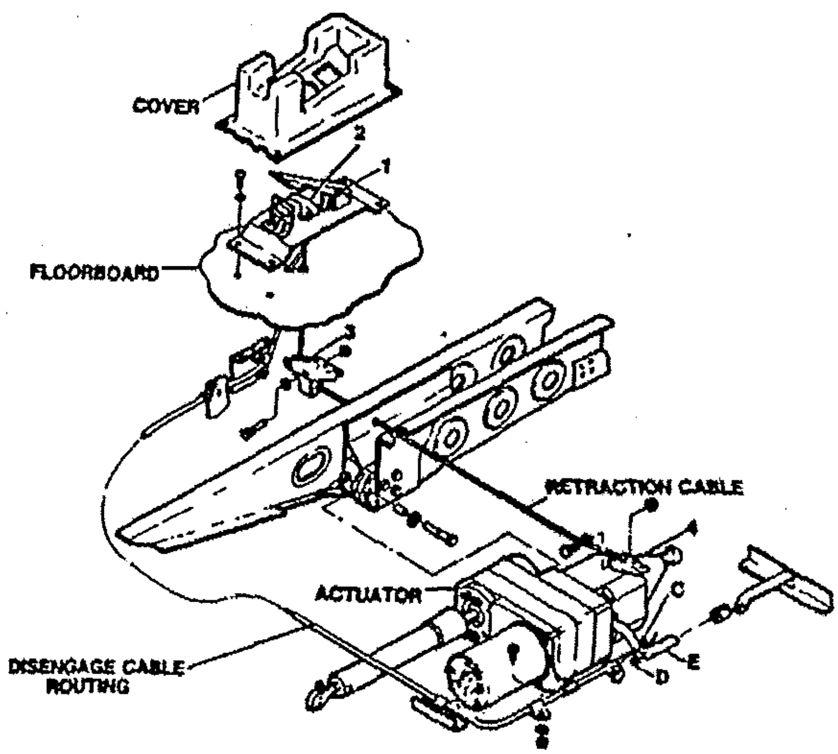
Single-disc setf-adjusting hydraulic brakes are featured on the main gear. The hydraulic brake reservoir also furnishes fluid for the hydraulic flap system on 1968 and earlier models. Gear position tights and a warning horn are standard equipment Bungee springs that preload the refraction mechanism in an over center position hold the gear down.

An air-pressure actuated safety-switch in the pilot system and squat switch in the landing gear electrical system prevent electric gear retraction on takeoff until a safe flying speed is attained.

A gear-throttle warning horn sounds when the throttle is set for 12 inches or less of manifold pressure with the landing gear up. The electric gear retraction system has a manual override system connected to the gear actuator that permits manual lowering of the gear in the event of an electrical malfunction.



EMERGENCY GEAR SYSTEM THROUGH 1977.



EMERGENCY GEAR SYSTEM, 1978 AND LATER.

CHECK OF GEAR RETRACTION SYSTEM

1. Raise the aircraft on jacks.

2. With master switch ON, gear switch in UP position, apply pressure to pitot tube. Verify gear retraction occurs at 65 K1AS +7.-4 K1AS. Allow gear to raise completely. Check for tire interference at wheel wells.

3. Close throttle and confirm gear horn sounds.

4. Inspect gear doors for proper closing. Lower gear.

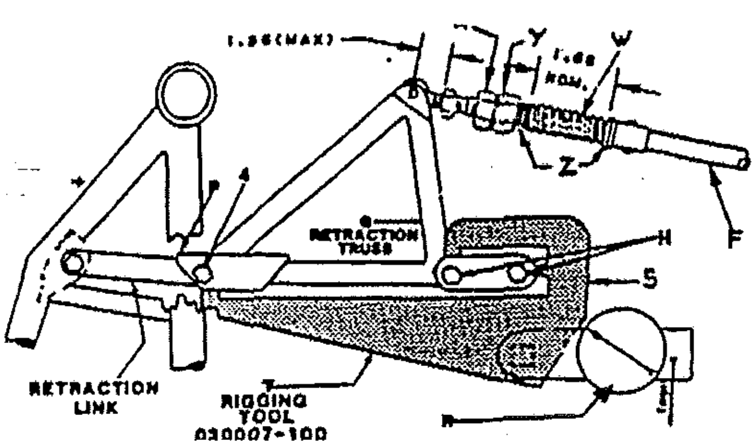
5. With zero airspeed, place gear switch in UP position, noting that both gear position lights and safety bypass switch illuminate.

6. Push and hold RED gear safety bypass switch to partially retract gear.

7. Pull "GEAR ACT" circuit breaker.

8. Check gear overcenter preload.
   a. While retracted measure nose gear bungee springs. Extend gear manually, stopping the moment the green GEAR DOWN light comes ON. Place gear switch in down position. Measure nose gear bungee springs. Deflection must be .032 to .070 inches. b. Check main gear overcenter preload. Place rigging tool P/N 30007-100 on retraction truss. Torque should be 250 to 280 in-lbs.

LEFT MAIN GEAR (FORWARD LOOKING VIEW)



TORQUE WRENCH 250-280INCH LBS

Gear Over center Preload Check

After the gear doors are installed at the factory no further adjustment should be required. However, should the inboard doors be removed for any reason the following rigging procedure should be used when reinstalling them.

1. Disconnect outboard gear doors at the forward and aft linkage.

2. Raise gear electrically to the full up position.

3. Forward leading edge and aft trailing edge of the inboard gear door should be tight against the wing skin and fair with the aft bubble fairing. Spacers should be added or removed as required to obtain a good fit with no binding or distortion with the gear in the UP position. AN960-10 washers may be used as spacers.

4. Reconnect outboard gear doors and check that the forward edge of outboard gear doors are faired with wing skin/wheel well opening and that there is no binding or distortion where links attach to door.

FLIGHT CONTROL SYSTEMS

The dual flight control systems can be operated from either the pilot or copilot seat All flight controls are conventional in operation, using push-pull tubes to link the control surfaces to the control wheels and rudder pedals. (Page 10-7).

Formica guide blocks maintain control tube alignment and dampen vibration. An interconnect bungee spring mechanism links the aileron and rudder systems to assist in control coordination. The co-pilot's rudder pedals are removable. The trim system sets the stabilizer angle of attack. .

Later models, with the longer fuselage, have a variable downspring in the elevator control system which refines the feel of the elevator in flight A bellcrank and cable tailor the spring tension appropriate for and trimmed position of the stabilizer. Models M20L and M have Rudder Trim Systems installed. (Page 10-8).

INSTRUMENTS

All flight instruments are in the shock-mounted flight panel. Engine instruments are in the co-pilot's panel. Pitot system air pressure operates the airspeed indicator. The instrument static pressure system has air pickup ports on each side of the tailcone. open to the atmosphere. An alternate static source is on the tower flight instrument panel. Instrument panel lights are manually dimmed.

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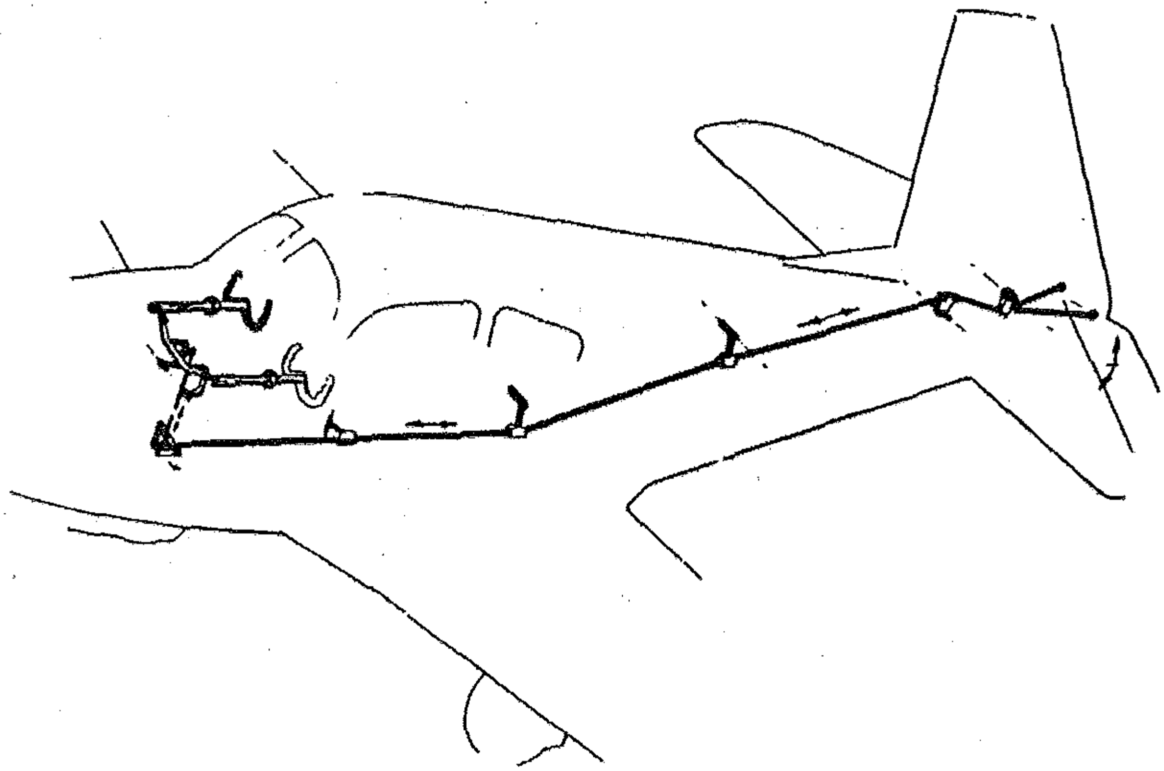
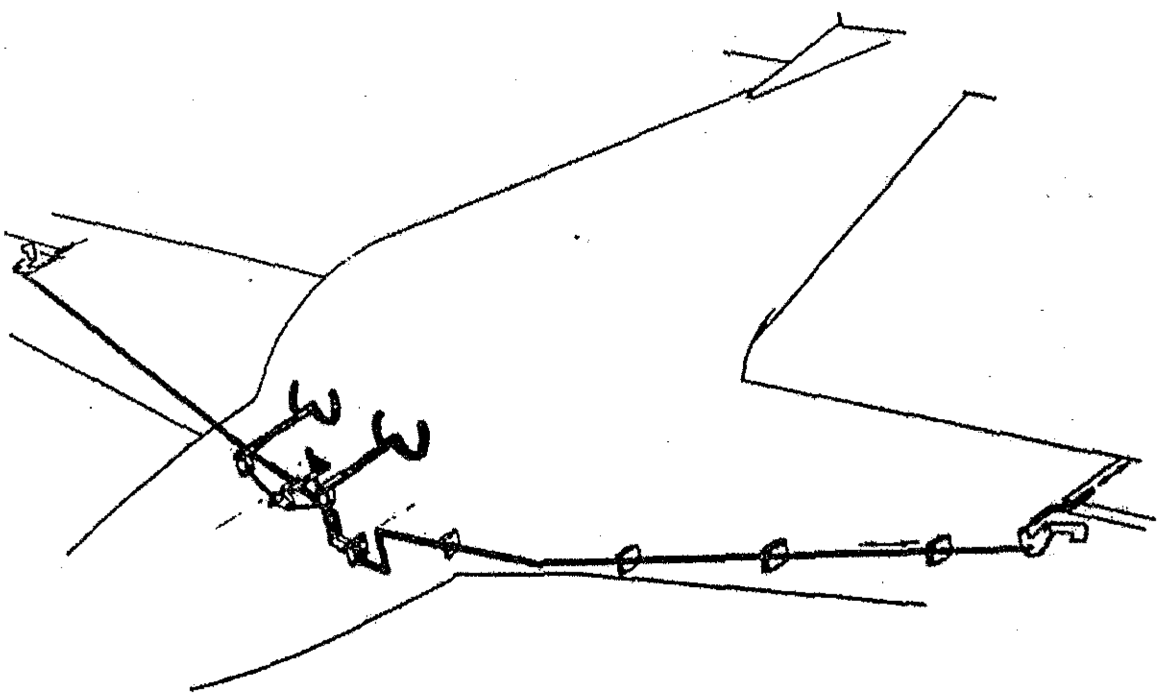
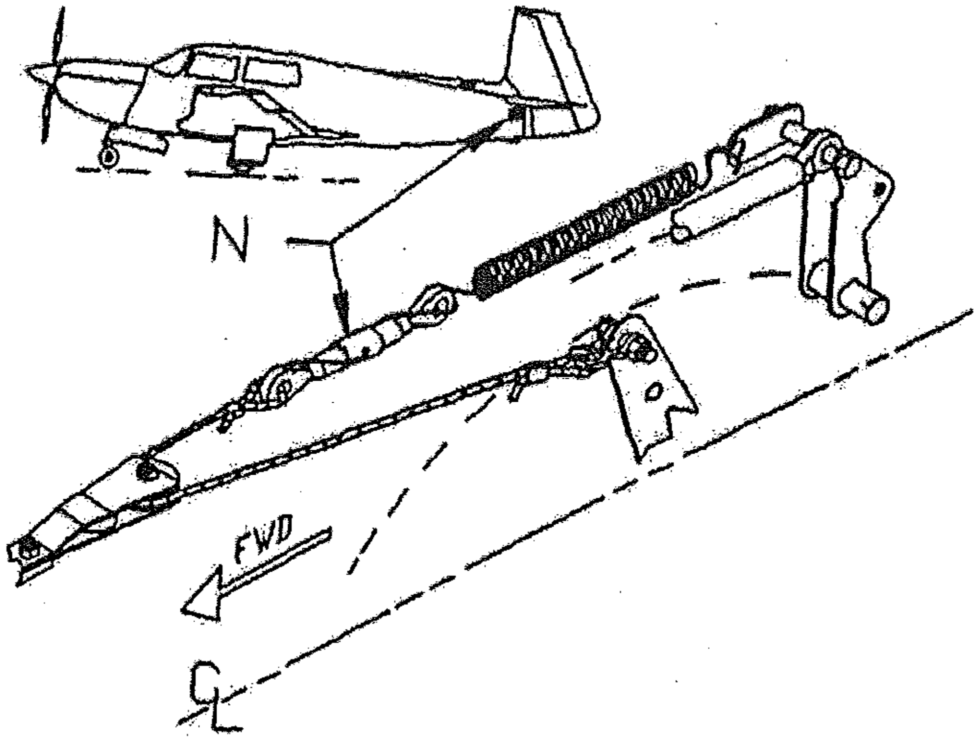


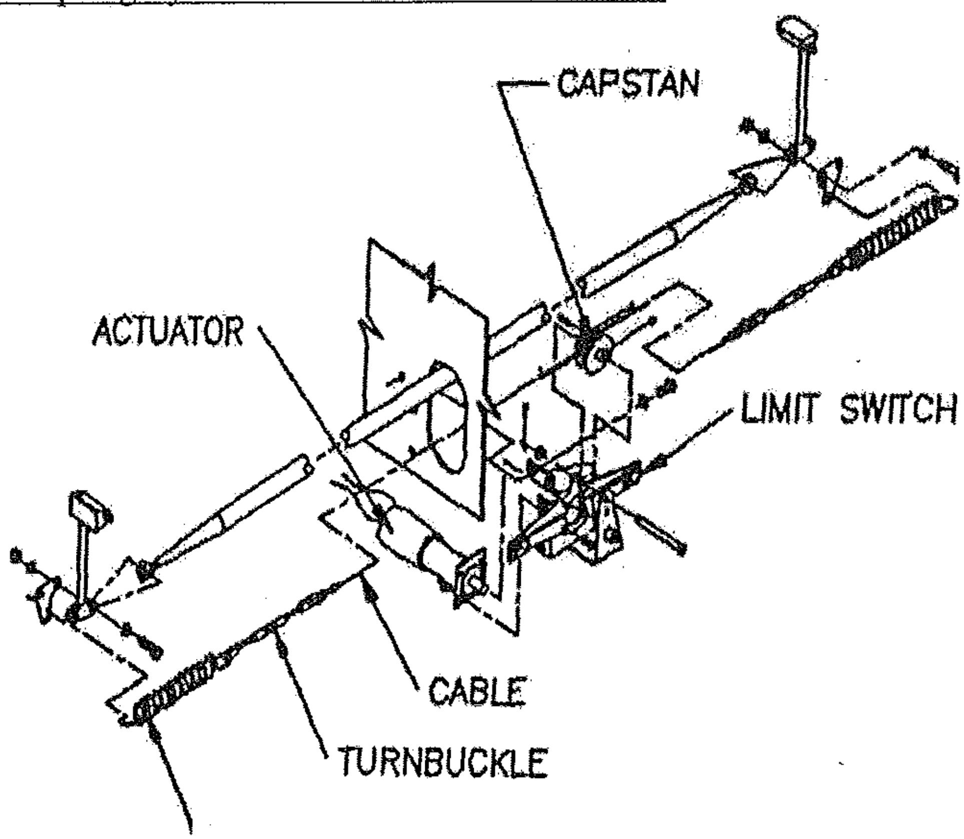
Elevator Control System



Aileron Control System



Variable Downspring System. Models M20L and M20M



Rudder Trim Rigging. Model M20M

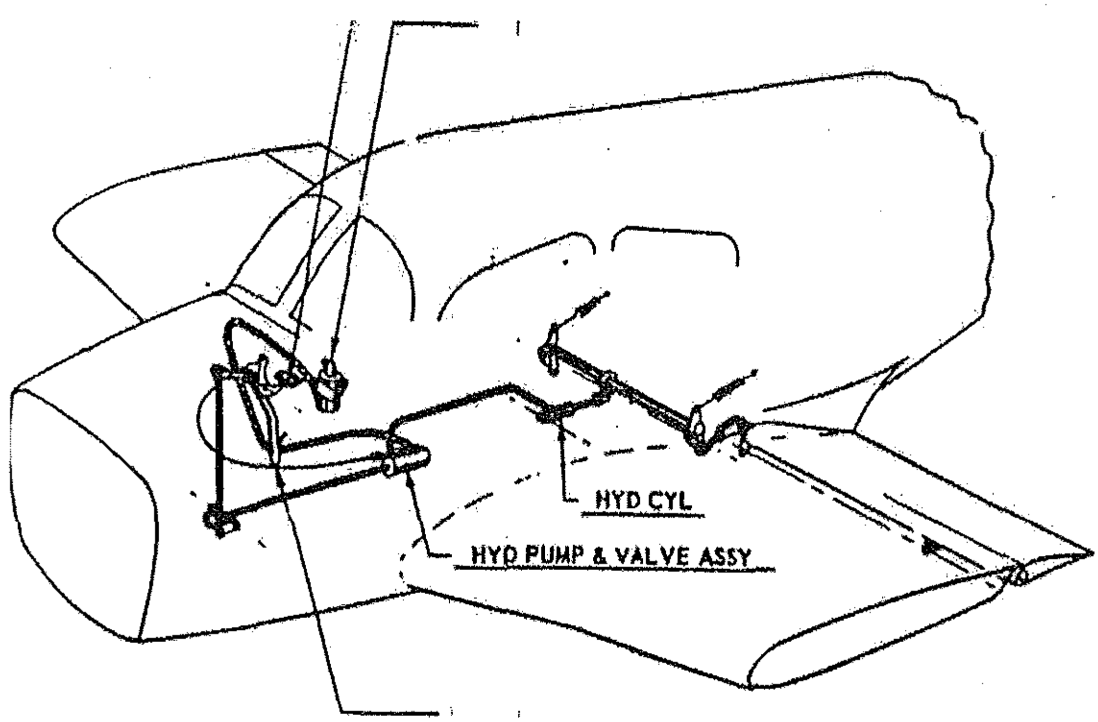
CABIN HEATING AND VENTILATING

A heater muff encasing the exhaust muffler is the source for cabin heat. Hot air from the heater muff mixed with ambient air controls cabin temperature. A manually operated overhead or ventral fin mounted airscoop provides additional cool-air ventilation. Air is routed from the cabin heater duct system to nozzles at the windshield base to defrost the windshield. An optional defrost blower motor system is now available on current models with retrofit kits for earlier models.

WING FLAP SYSTEM

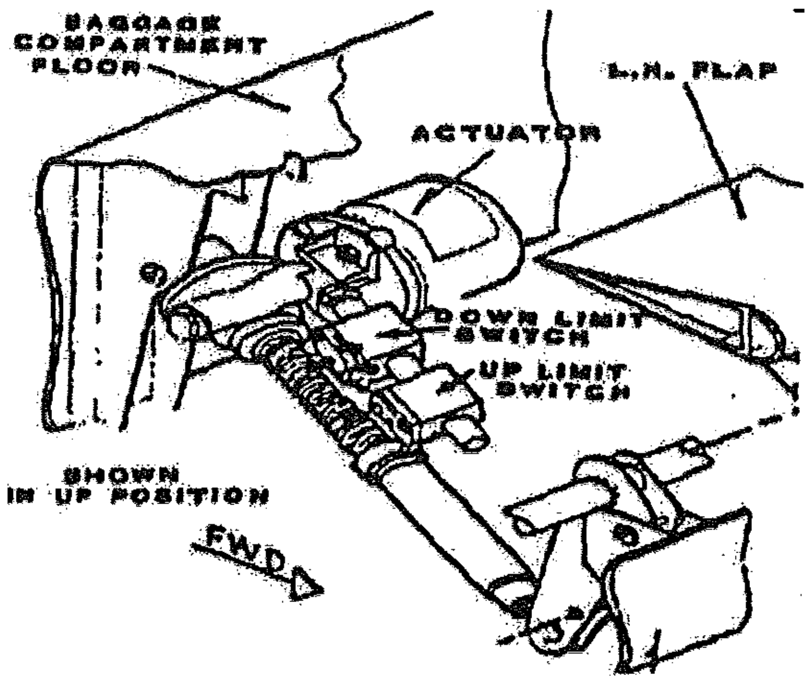
1962 through 1968 Models: A hand-operated hydraulic pump operates the flap actuating cylinder. A valve operated by an airfoil-shaped control on the instrument panel controls the flaps and releases hydraulic pressure at a slow rate as air pressures and retraction springs raise the flaps. The hydraulic fluid reservoir is common to both the flap and brake systems.

RELEASE CONTROL RESERVOIR



FLAP HANDLE

Hydraulic Flap System



Electric Flap System

Wing flaps on 1969 and later models are electrically actuated and controlled by a spring-loaded up-off-on switch on the engine control pedestal. The 1975 models have a three-position switch to pre-select flap settings. For M20M. S/N 27-0108 through TBA. the Flap System incorporates a preselected feature which allows flaps to be activated as desired: UP, TAKE OFF or DOWN.

BRITTAIN WING LEVELER (Positive Control) SYSTEM

The Brittain Wing Leveler system, commonly referred to as the P.C. system, is a pneumatically operated two-axis automatic control mechanism which operates from takeoff through landing and senses both roll and yaw in flight The Positive Control system was installed on pre-M20J models through mid-1977 and uses the engine driven vacuum pump as its power source.

The P.C. system is super-imposed on the manual flight control system and consists essentially of a gyro-sense element in the turn coordinator which meters vacuum to cylinder-piston servos. The system has tour servo units: one attached to each outboard aileron bell crank, and the remaining two attached to the rudder control tubes in the tail cone.

A push button disconnect valve in the pilot's control wheel operates a pneumatic relay, supplying vacuum to the gyro-sense element. 1975 and later models have an electrically operated valve controlled by a momentary type switch on the control wheel. In either system, depressing the push button relieves all servo vacuum and the P.C. system immediately becomes inoperative. Releasing the push button reactivates the system. The system can be overpowered with little effort and with no damage to the aircraft or P.C. system components.

The turn coordinator is the roll and yaw sense element in the P.C. system. Either a roll rate or a yaw rate will cause the turn coordinator to produce an output signal that is fed to a spool-sleeve rotary valve. The spool rotates inside the sleeve, moving to a position between a vacuum supply port and one of the vacuum output ports.

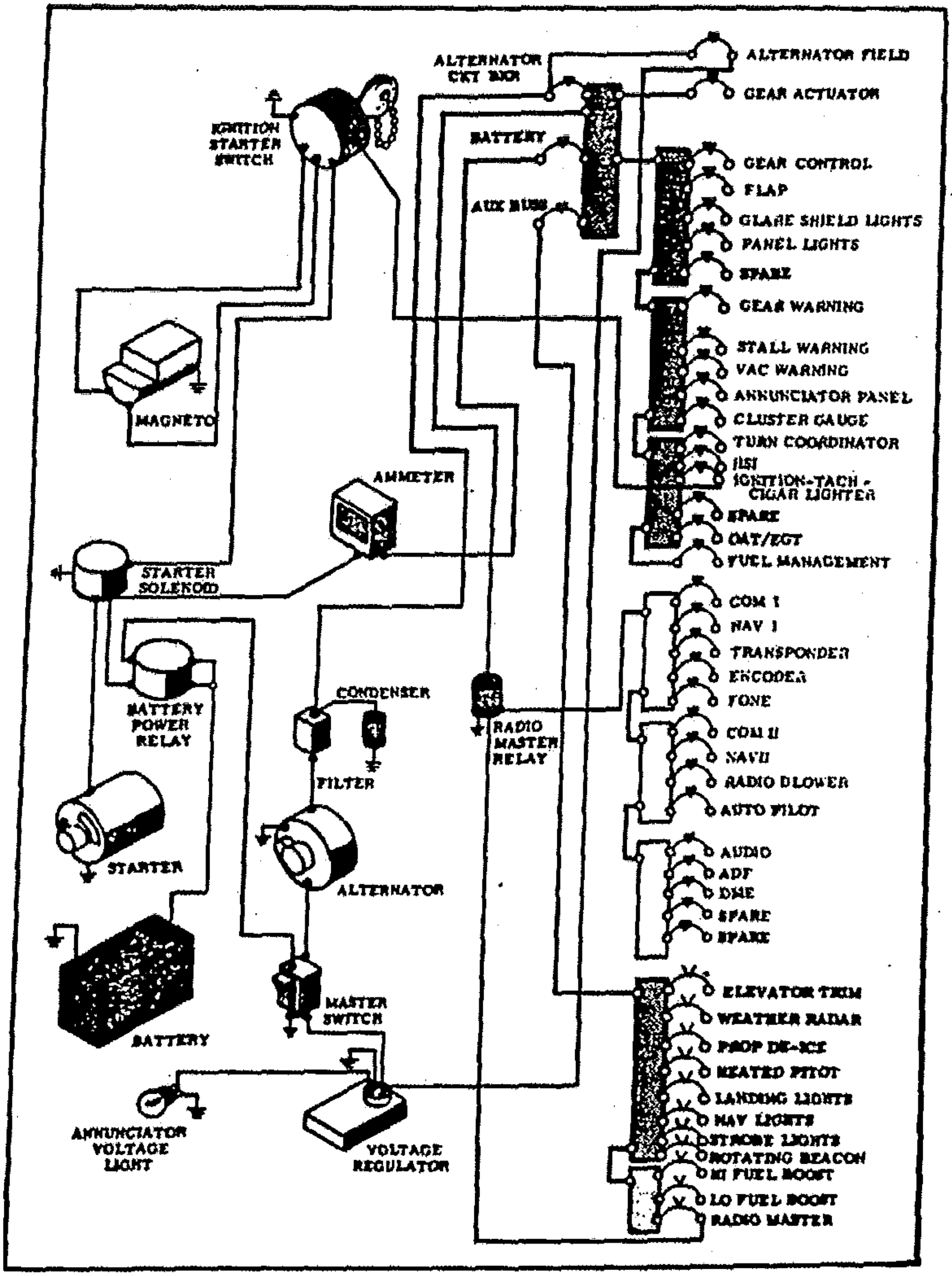
The other output port is then open to atmosphere, bleeding vacuum. A vacuum differential is thereby directed to the proper pneumatically operated servo to correct the original aircraft roll or yaw error. In straight wings-level flight the spool remains centered, vacuum differential is zero, and the servos balance right and left.

The aircraft must be rigged to fly wings-level with the turn coordinator centered and with the P.C. system disengaged. With the P.C. engaged, a property rigged and trimmed aircraft should hold an average heading over a fairly long period of time in smooth air. However, P.C. cannot be expected to maintain an absolute pre-selected heading without the installation of a magnetic heading reference. The addition of an omni-coupler unit and a pitch and altitude control unit provides a three axis autopilot

ELECTRIC POWER SYSTEM

The master switch and power relay control the electrical power system, which is comprised of a 50-amp 12-volt generator or a 60-amp 12-volt alternator, a voltage regulator, and a 35 amp-hour battery, or a 70 amp, 28 volt alternator, and voltage regulator. Standard equipment on M20M models includes two 24 volt. 10 amp-hour batteries and dual alternators. Alternator systems have an over voltage protective relay and over voltage annunciator light. All 1969 through 1974 models have automatic annunciator fight dimming systems.

M20K models S/N 25-0001 thru 25-0999 have a 14 volt, 70 amp alternator with a transistorized voltage regulator/over voltage control. An optional 28-volt. 70-amp second alternator may be installed. A 24 volt, 10 amp hr storage battery is installed in the tail cone.



Typical Electrical System Schematic

M20M models have two 28 volt, 70 amp alternators utilizing transistorized voltage regulators/overvottage controls. Two 24 volt, 10 amp hr. storage batteries are installed in the tail cone. The M20L has dual 70 amp alternators, with the starter using both batteries connected in parallel.

Circuit breakers or circuit breaker switches protect the electrical wiring and equipment from overloads. On B, C, D. E. F & J Models, standard electrical equipment includes: a 250-watt landing light (24-0001 thru 24-3153). M models & J models from S/N 24-3154 are equipped with two 100-watt landing and two 100-watt taxi lights. K models are equipped with two 100-watt landing lights.

All models have navigation lights, interior lights, gear and stall warning systems, an electrical boost pump. and an electric starter, electric gear retraction system with manual override, an electrical flap system and starting with S/N 24-3154 an electric cowl flap actuation system.

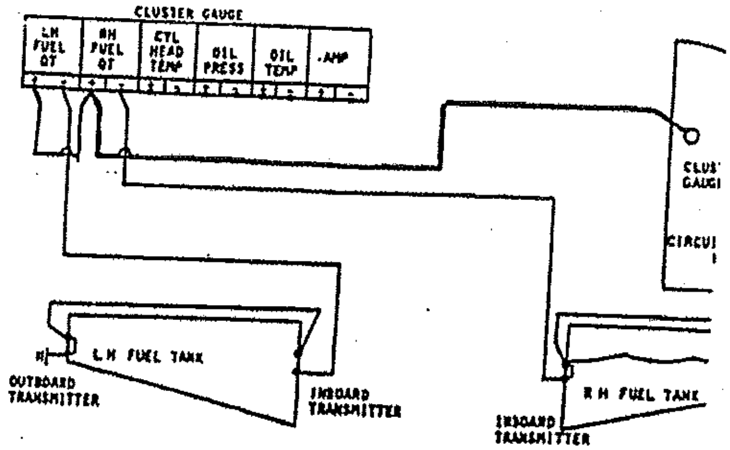
M20K S/N 25-1000 thru 25-TBA have an aft facing position light (clear) located on each wing tip trailing edge. On S/N 25-1225 thru 25-TBA, landing/taxi lights are located in the leading edge of each wing. Models M20L and M20M are basically the same as the later M20K's.'

FUEL SYSTEM

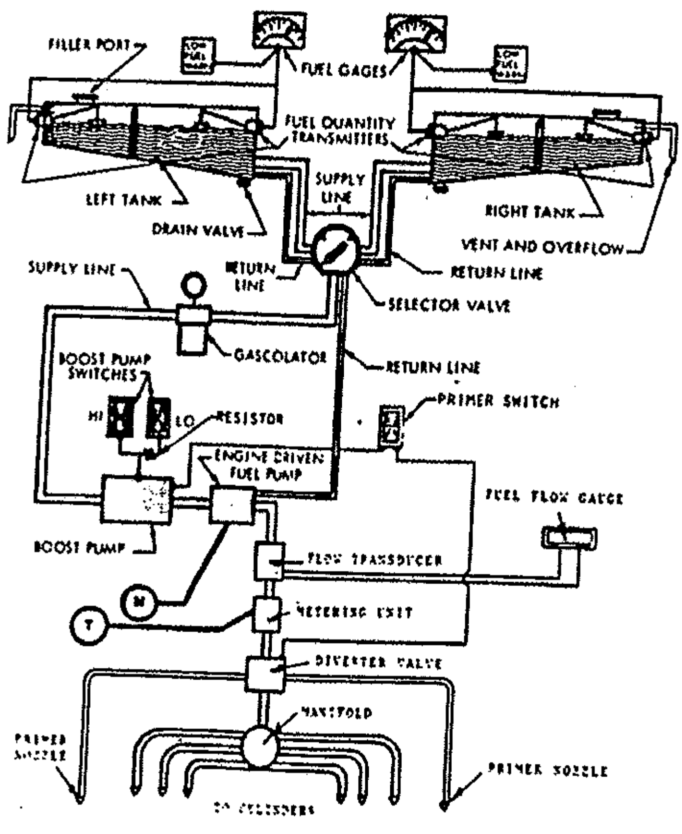
The fuel system has internally sealed, integral wing tanks in the forward, inboard section of each wing. Vents at the aft, outboard comer of each tank vent downward through the lower wing surface. These tank vents are designed as a tube-within-a-tube to help prevent freezing-Fuel sump drains are at the lowest point in each tank. Fuel feeds from either tank to a valve through a gascolator integral with valve or separate with a low-point drain. Selector valve and drain valve screen or gascolator screen should be cleaned every 50 hours.

The emergency electric fuel pump is in the bottom left forward section of the fuselage just aft of the firewall. Fuel feeds from either tank through the selector valve to the emergency pump. then to the engine-driven fuel pump and to the carburetor or fuel injector system on the engine. Fuel quantity transmitters in each tank are wired to fuel quantity gages in the engine cluster gage. The master switch, left side of the pilot panel, turns on the fuel quantity indicating systems. Visual fuel level indicators ("tabs") inside the tank show the 25-gallon level in each tank can be seen through the filler ports.

FUEL SYSTEMS SCHEMATIC

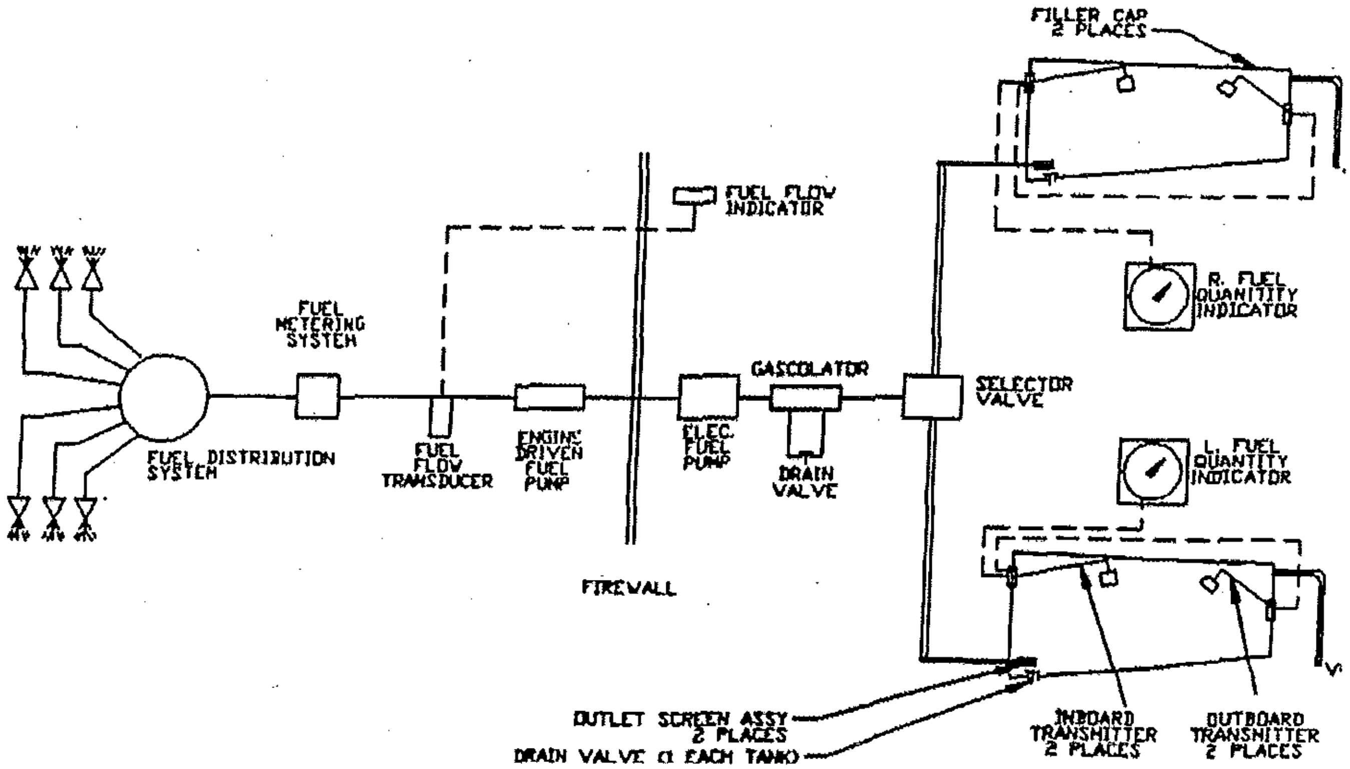


Fuel Gauging



M20K Fuel System Schematic

Mooney Aircraft Pilots Association Safety Foundation

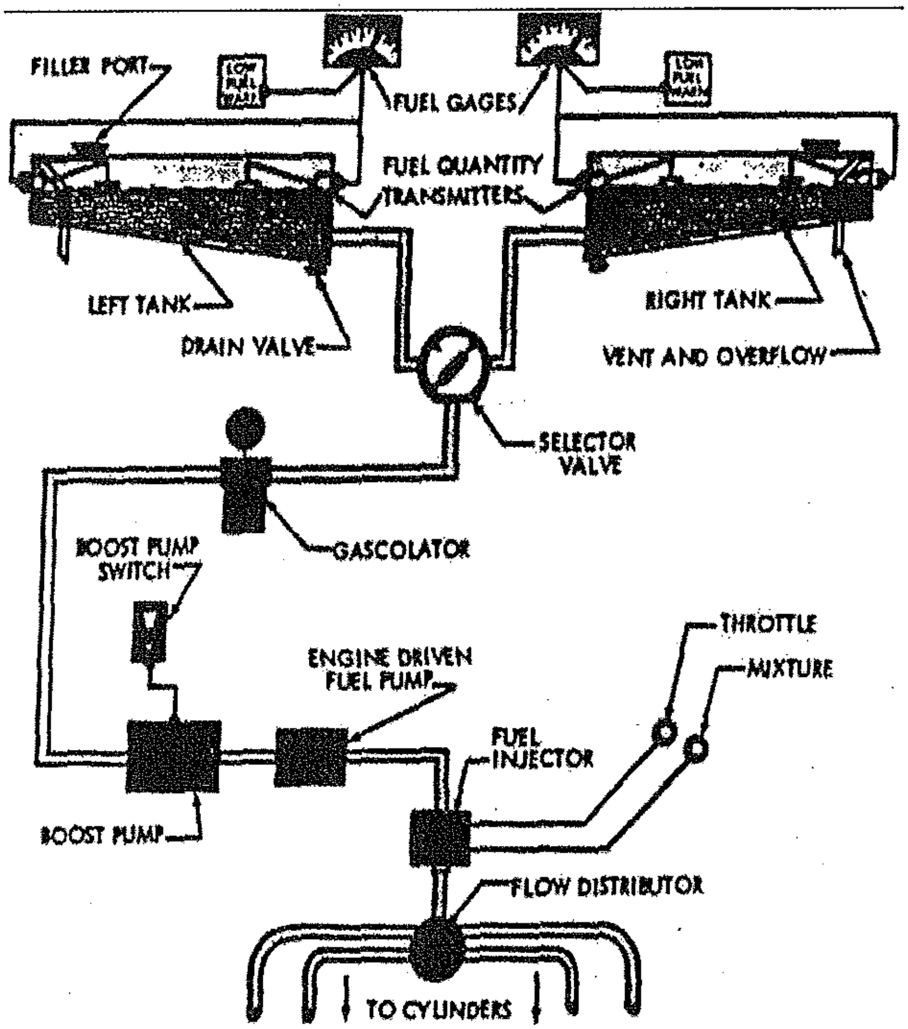


M20M Fuel System Schematic

Beginning with the 1978 M20J Model, a low fuel warning annunciator light for each tank is activated when the useable fuel quantity goes below 2.5 gallons in that tank. Optional visual fuel quantity gauges are located on the wing of later models and may be used for partial fuel loads as necessary.

On 200 hp Lycoming engines (models M20E. F, and J). a Bendix RSA-5AD1 fuel injection system uses measured airflow in a stem-type regulator to convert the air pressure into a fuel pressure. This fuel pressure differential is applied across the fuel metering section of the fuel injector, making fuel flow proportional to airflow. The injection system is comprised of the injector, flow divider, air-bleed nozzles, and associated lines and fittings. The M20L Porsche engine has a K-Jetronic Fuel Injection System by Bosch.

The Lycoming fuel injection controls on M20E, F and J models do not include an engine primer. Fuel will be sprayed into the intake manifold whenever there is pressure in the fuel system and the mixture control is open. ft is necessary. therefore, to exercise caution when operating the boost pump to be sure that the mixture control is in the IDLE CUTOFF position.



M20 FUEL SYSTEM SCHEMATIC

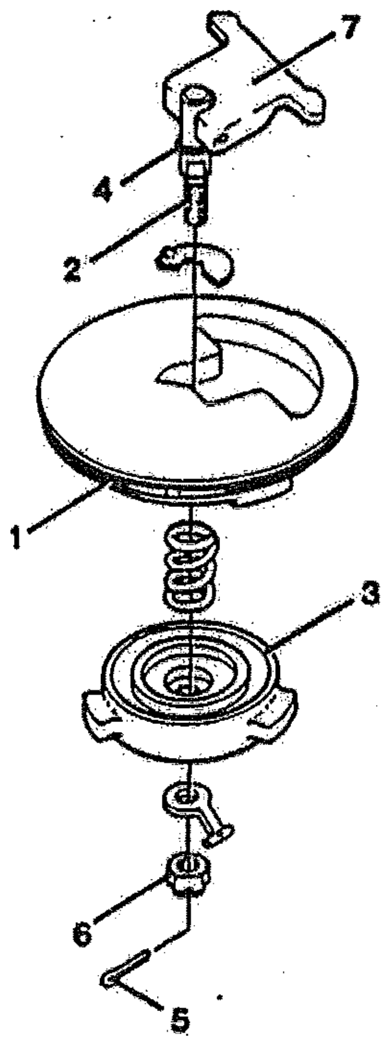
For the 210 hp turbocharged Continental engines on M20K S/N 25-0001 through 25-1225, a primer switch energizes a valve on the engine and also turns on the boost pump. On S/N 25-1226 thru 25-TBA, priming is accomplished by pressing the LO boost pump switch. There is no independent primer system on the M20M, which operates basically as the M20J.

During engine starts on the M20L, when the manual enrichment is actuated, an electromagnetic valve (cold start valve) injects additional fuel into the intake manifold pipe while the starter is operated.

The 180 hp Lycoming engines in models M20C & G use a Marvel-

Scheibler model MA-4-5 carburetor, a single-barrel float type with a manual attitude mixture control and idle-cutoff. The carburetor is mounted on the bottom of the engine oil sump. Vaporized fuel absorbs heat from the sump, cooling the oil and vaporizing the fuel evenly.

Fuel filler cap assemblies on all models should be checked in accordance with SB M20-229A at intervals of every 100 hours or annual inspection.



Fuel Filter Cap Assembly

Fuel vents on the outboard rear comers of both fuel tanks allow for overflow and fuel tank ventilation. Vents should be checked frequently for obstruction.

To check fuel tank vents:

1. Block entire fuel tank vent by slipping a short length of rubber hose over tube end projecting below wing lower surface.

2. Remove fuel tank filler cap. Blow gently into rubber hose. Air should be felt coming out of filler port.

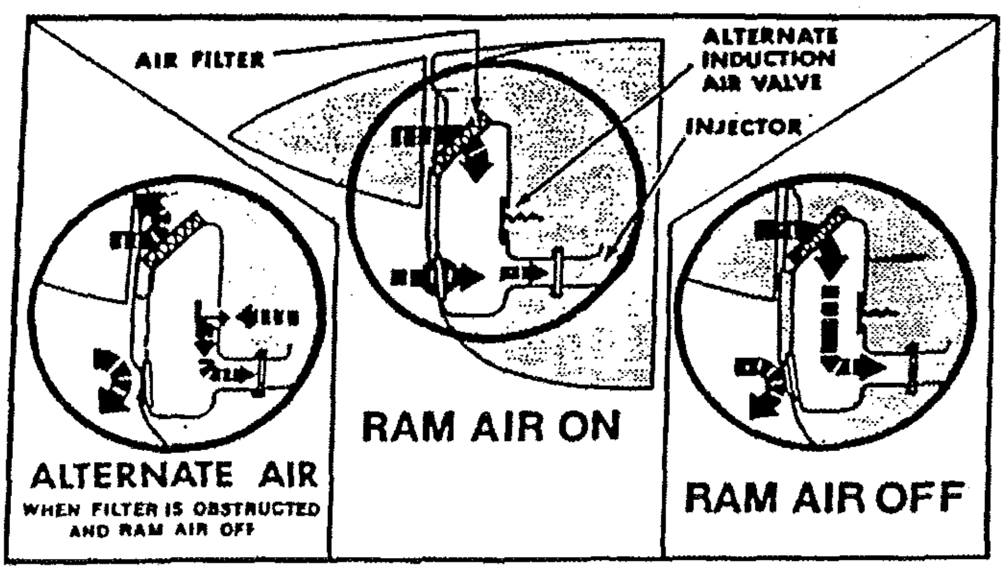
3. If stoppage is found, dear vent prior to flight, since fuel starvation could result from vent stoppage.

RAM AIR

The ram-air feature was incorporated with the 200 horsepower engine in M20E and later models, including M20J production through 1991. However, the power increase on the M20J is barely noticeable, due to its improved induction system. Mooney has designed a retrofit kit to remove the ram-air feature, to make earlier M20J's comparable to the MSE (non ram-air) version introduced in 1991.

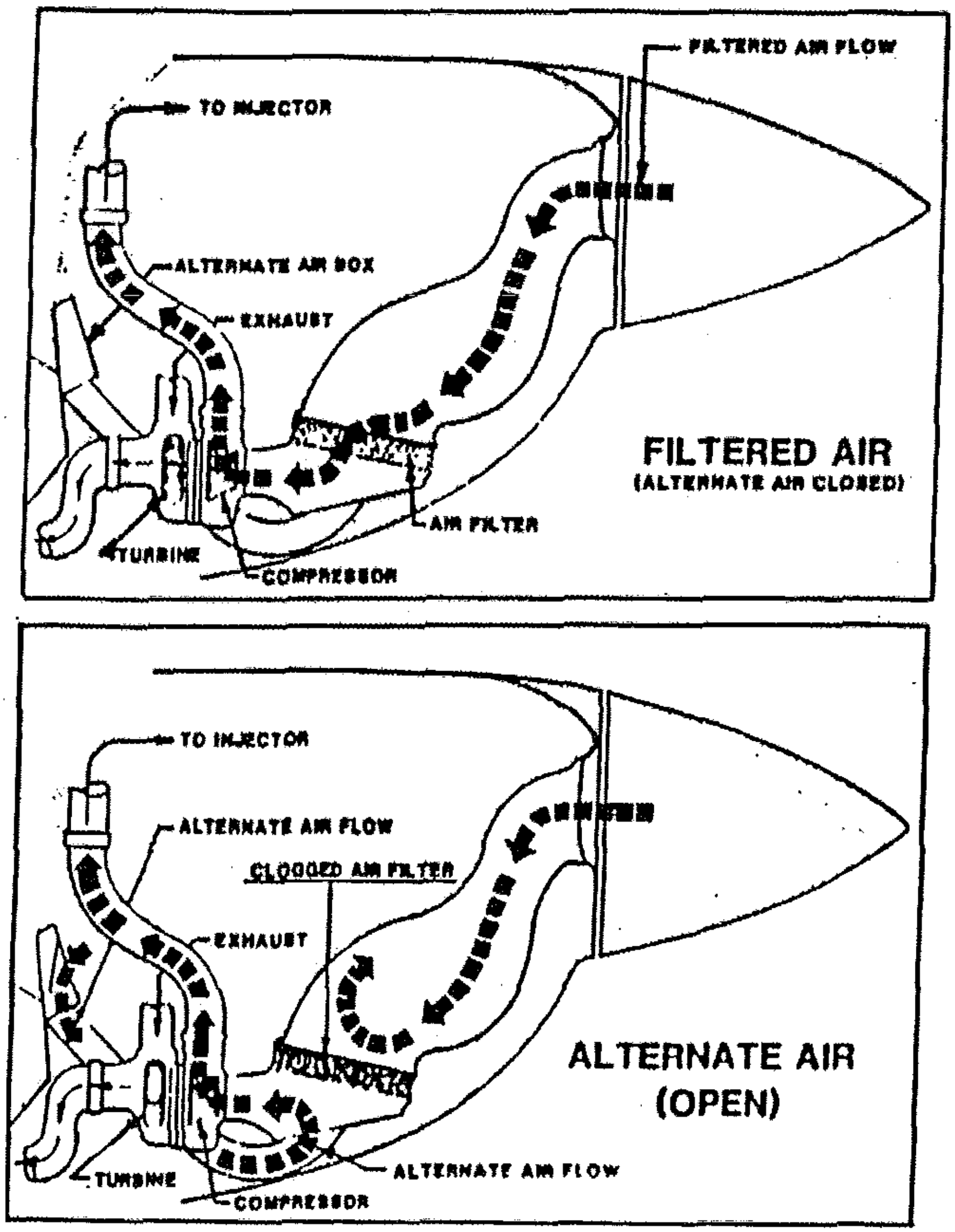
In pre-M20J models, using ram-air increases manifold pressure over 1" Hg by allowing engine induction air to partially bypass the induction air fitter. Use of ram-air must be strictly limited to dean. dust-free air, as the engine operates on direct unfiltered air when the ram air control is pulled on.

When ram-air is on allowing unfiltered air to enter the engine, the ram-air annunciator light will illuminate when the landing gear is down. Should the induction air filter clog, a spring-loaded door in the induction system will open by induction vacuum to allow alternate air to enter the engine.



M20J Engine Air Induction System

The induction airflow path on a typical turbo charged aircraft is shown on page 10-19. Induction system components include the air filter, alternate air box, turbocharger compressor, throttle, manifold tube and cylinder intake ports.



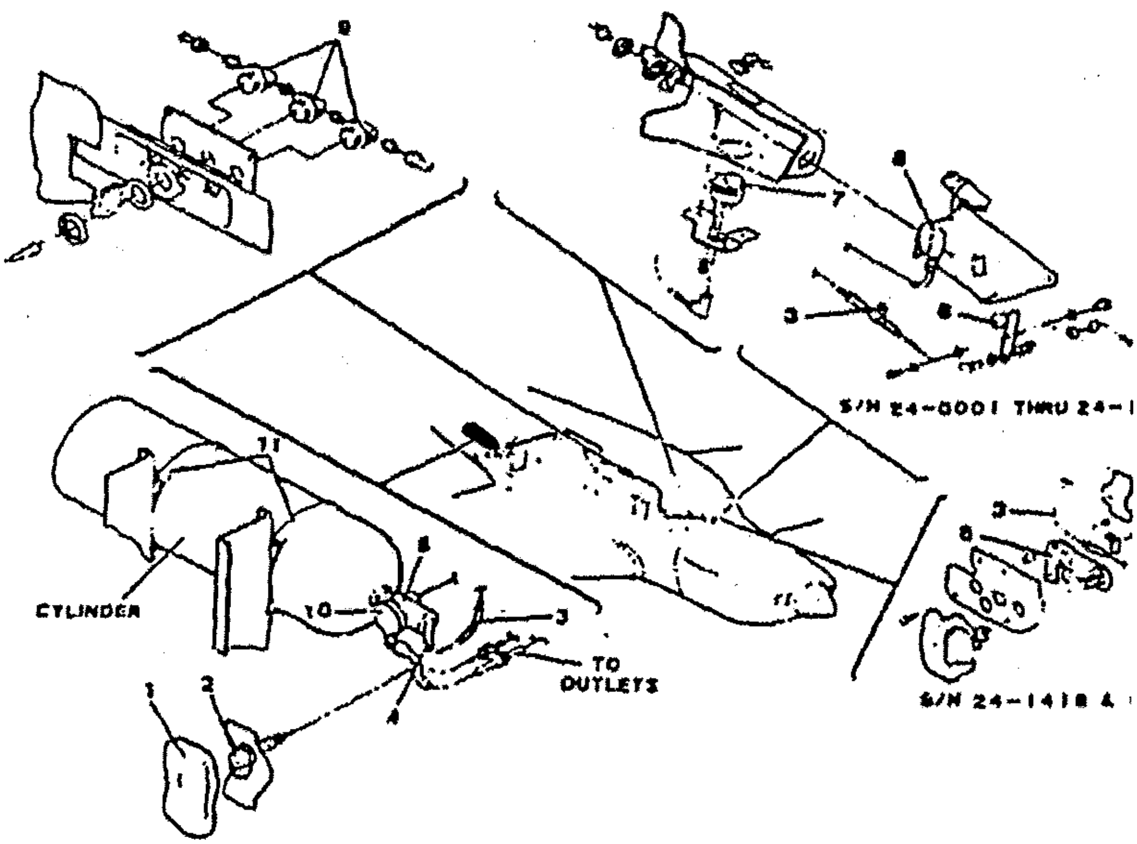
M20K Air Induction System

OXYGEN SYSTEM

The oxygen system is an optional installation on M20J and M20K models, and standard on M20M models. The system consists of a 76 (metal) or 77.1 (composite) cubic foot cylinder located in the tail cone immediately aft of the baggage compartment bulkhead. A reducing valve and an altitude-compensating valve are connected to the cylinder to regulate the oxygen flow for a given altitude. A compensating valve distributes aviator's oxygen to the pilot and passengers. The system in activated by the control handle to the left of the pilot

MOONEY AIRCRAFT SYSTEMS

A gauge on the pilot's armrest adjacent to the control indicates the pressure of the oxygen cylinder. When the cylinder is full the pressure will indicate 1850 psi at 21 degrees C. The system is serviced aft of the baggage compartment door.



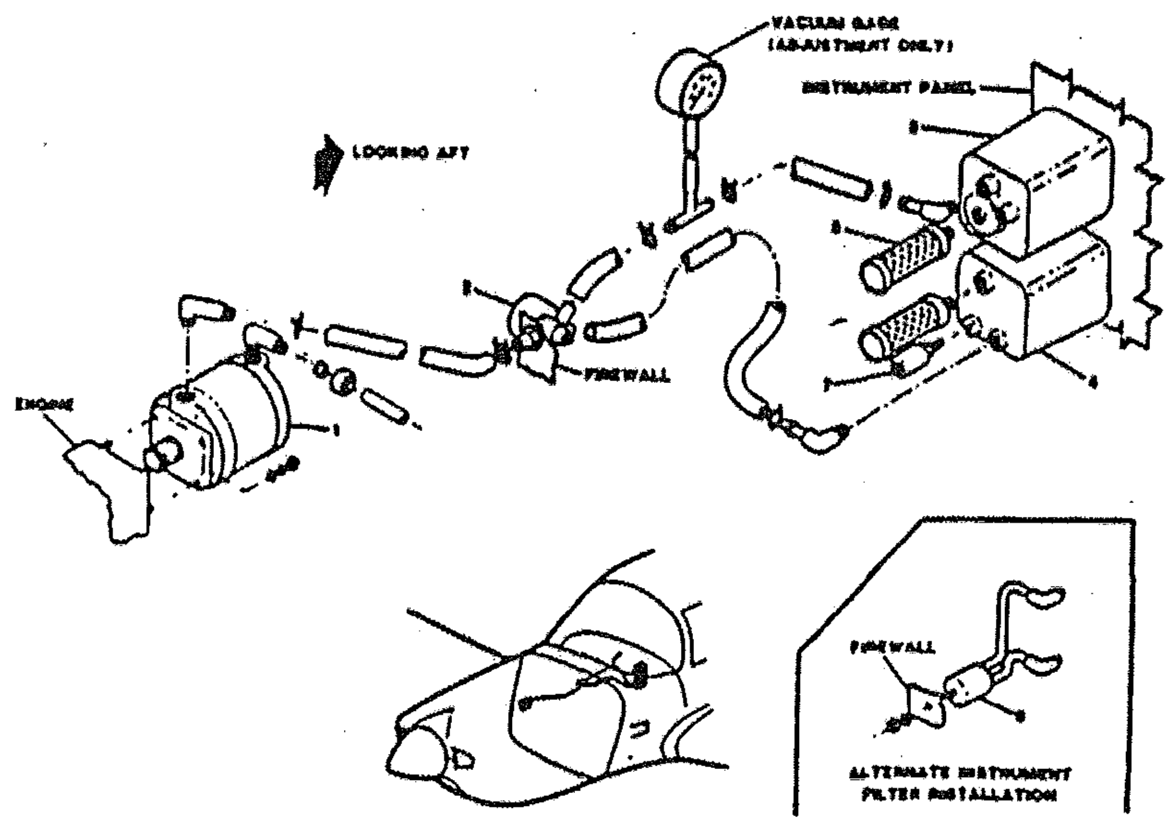
Typical Oxygen System

WARNING

> Proper safety measures must be employed with oxygen system maintenance is being performed or a serious fire hazard will be created. Avoid making sparks and keep all burning cigarettes or fire away from the vicinity of oxygen. Make sure that hands, tools, and clothing are clean, particularly with respect to oil *OR* grease, for these will *IGNITE* upon contact with pure oxygen under pressure

INSTRUMENT VACUUM SYSTEM

An engine driven dry air vacuum pump supplies suction for the vacuum operated gyroscopic flight instruments, typically the Directional Gyro and Artificial Horizon. The air is passed through several filters before entering the instruments. A vacuum regulator valve is incorporated to maintain the required operating vacuum throughout the engine power range. Idle RPM settings will normally not provide adequate vacuum for satisfactory instrument operation.

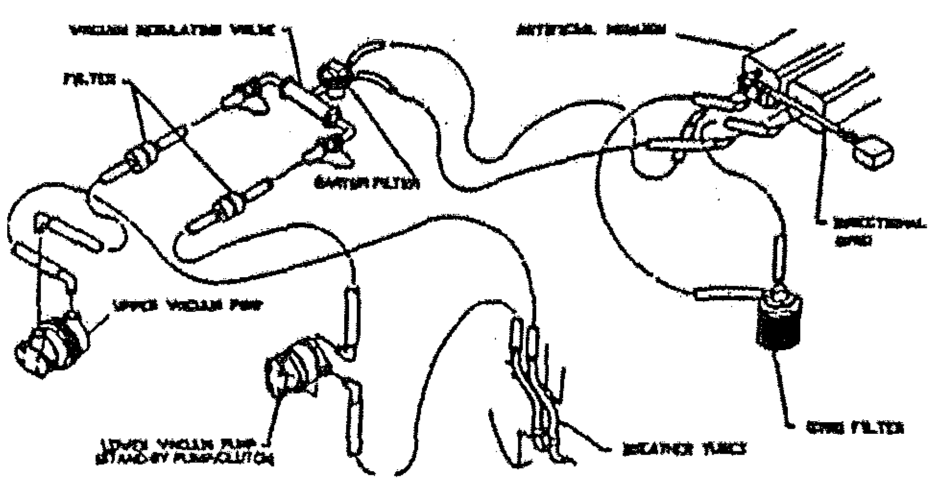


Typical Instrument Vacuum System

A red vacuum annunciator light will flash when available vacuum drops below the *4.25 ± 2.* In. Hg. required to operate the instruments. The vacuum annunciator light glows steadily when vacuum exceeds the normal setting of 5.5 ± .2 In. Hg.

A standby vacuum system kit is available. This kit can be installed by the factory or in the field. The standby vacuum system should be activated manually when the "LOW VAC" light flashes on the regular engine driven system.

On M20M aircraft the standby vacuum system is standard and is installed on the engine accessory pad through an electrically activated dutch assembly. The standby vacuum system should be activated manually when the "HI/LO VAC" light flashes on the regular engine driven system. This is done by pushing the "STBY VAC" switch, located on the instrument panel, to the "ON" position. There is no other check available for the pilot.



M20M Instrument Vacuum System

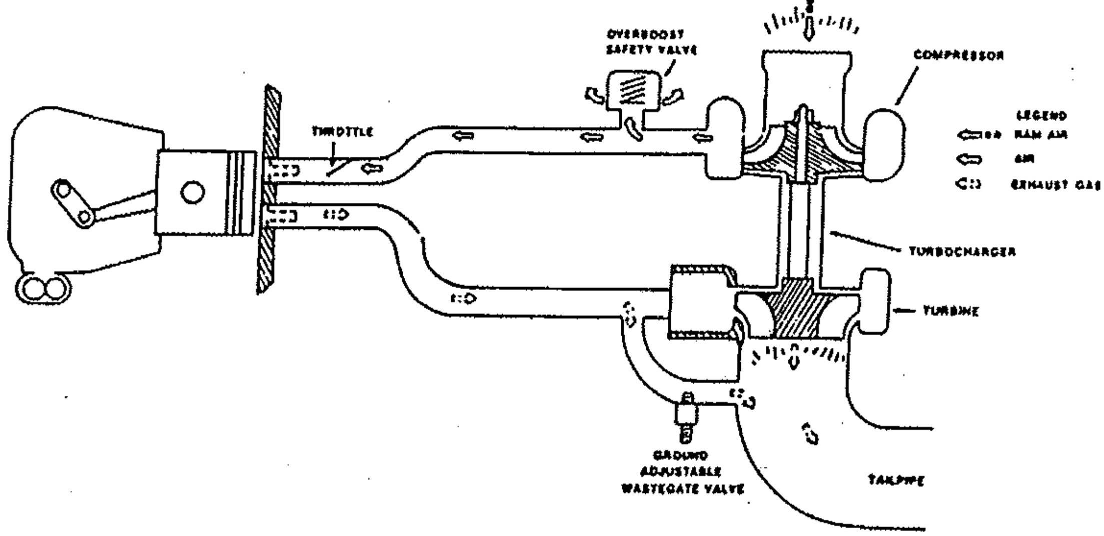
TURBOCHARGER OPERATION

A turbocharger increases the power output and efficiency of the engine by supplying compressed air to the intake manifold. Engine exhaust is routed to the turbine of the turbocharger assembly, and a wastegate assembly controls the volume of exhaust gas passing over the turbine wheel.

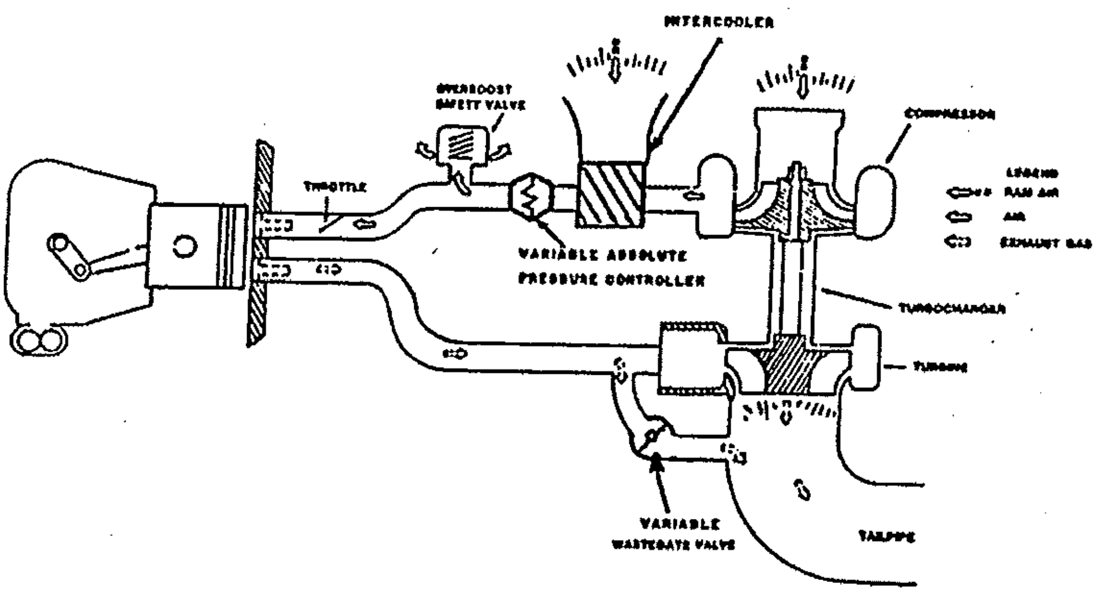
Exhaust gas passing over the turbine wheel causes the compressor, mounted on the same shaft, to rotate. Ambient air is filtered, routed through the compressor, and delivered to the engine. As engine power is increased, the flow of exhaust over the turbine wheel also increases, resulting in a proportionate increase in the compressed air output by the turbocharger.

The engine incorporates overboost protection within the pressure controller on wastegates (252 and TLS) or overboost safety valve on 231 models. Should the primary air source become obstructed, the engine automatic alternate air system will allow air from inside the cowling to pass through the compressor and into the engine. This air is warmer than ambient outside air so less power will be available at a given throttle setting.

TURBOCHARGER SYSTEMS



M20K/231 Turbocharger System



M20K/252 Turbocharger System

Mooney Aircraft Pilots Association Safety Foundation

EXHAUST SYSTEM SERVICING

Exhaust System Servicing (reprinted from M20M Maintenance Manual with permission of Mooney Aircraft Corporation)

MOONEY AIRCRAFT CORPORATION M20M SERVICE AND MAINTENANCE MANUAL

81-30-00 - EXHAUST SYSTEM SERVICING

1. CLEANING

To properly inspect the exhaust system, components must be clean and free of oil, grease, etc. Clean as follows:

A. Spray engine exhaust system components with a suitable solvent (Stoddard Solvent), allow to drain and wipe dry with a clean cloth.

WARNING
Never use highly flammable solvents on engine exhaust systems.

WARNING
Never use a wire brush or abrasives to clean exhaust systems or mark on the system with lead pencils.

2. VISUAL INSPECTION OF COMPLETE SYSTEM

A thorough inspection of the engine exhaust system will detect any breaks or cracks causing leaks which might result in the loss of optimum turbocharger efficiency and engine power. Inspect per the following procedures:

NOTE
This inspection should be conducted when the engine is cool.

A. Inspect exhaust stacks for burned areas, cracks and looseness. Insure that attach bolts are properly torqued.

B. Inspect exhaust clamp for cracks, looseness and proper torque.

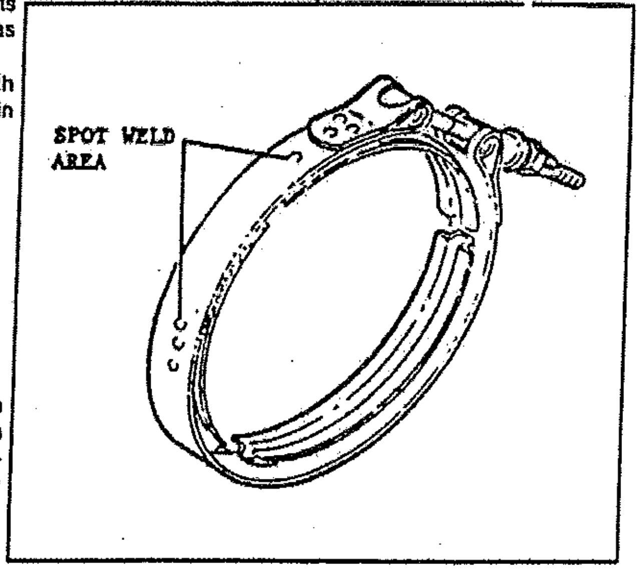
NOTE
During inspection, particular attention should be given to condition of the clamp flanges, clamp outer band spot welds, slip joints and welded areas.

81-30-01 INSPECTION MULTI-SEGMENT "V" BAND CLAMP

1. Using crocus cloth, clean outer band of the multi-segment "V" band clamp. Pay particular attention to the spot weld area on the clamp.

2. With clamp properly torqued:

A. Inspect outer band in the area of the spot weld for cracks (See Fig.81-2). If cracks are found, replace clamp with new multi-segment "V" band clamp.



"V" BAND CLAMP SPOT WELD AREA CHECK
FIGURE 81-2

NOTE
When replacement is required, install new "V" vand clamp over the exhaust flanges and torque to correct value. As clamp is tightened, lightly tap it circumferentially in a radial direction with a rawhide or soft plastic mallet.

81-40-00 - PERIODIC REPLACEMENT COMPONENTS

It is recommended that all exhaust system pipes, clamps and miscellaneous mounting hardware be replaced at engine overhaul time (2000 Hours). However, a thorough inspection of all components should be made any time the exhaust system is removed from the engine for component replacement. The inspection should be made in the interest of preventive maintenance.

NOTE! Even though the above information is an exhaust system inspection recommended for the M20M, it is highly recommended that some of the above inspections be applied to the M20K Turbo exhaust system along with the requirements in the M20K maintenance manual. The M20K has numerous hose tube connectors that deteriorate rapidly due to the high engine temperature in the engine compartment. It is highly recommended that frequent inspections of these systems be accomplished.

NOTES

CHAPTER 11. AVIATION PHYSIOLOGY

By Robert A. Achtel, MD

ARTICLE 1
RESPIRATORY GASES

11.1 NORMAL AND ABNORMAL GAS EXCHANGE

(a) NORMAL: Normal respiration is automatic and occurs without thought. As we take a breath we depress our diaphragms and raise our ribs creating a partial vacuum within our chest cavity. The atmosphere, which surrounds us, which is at a greater pressure, (15 pounds per square inch at sea level), then drives a fresh supply of air into our lungs. Humidification, which normally occurs within the nasal passages, is not sufficient to prevent dehydration when the inspired gas mixture contains supplemental oxygen. All oxygen produced in this country contains only 2-4 parts per million (PPM) of water vapor. This equates to less than 1% water vapor regardless of what is stamped on the outside of the cylinder (aviation v. medical). To prevent dehydration the pilot needs to replace the water lost during exhalation (insensible loss). This water loss is increased during hyperventilation and excessive talking where inspiration occurs primarily through the mouth. The total volume of air, which is inhaled, would be reduced in a pilot with restrictive lung disease, e.g., emphysema.

(b) ABNORMAL: As we ascend, the air that we breathe becomes thinner. If we assume that the density of air is 100% at sea level, then its density would be 50% at flight level (FL) 180. At FL 180 we are under one half an atmosphere of pressure. The atmospheric gas mixture that we inhale contains approximately 20% oxygen (02) and 78% nitrogen. At sea level we would inhale a quantity of 02 we shall refer to as 100%. At FL 180, we would inhale only one half as much oxygen, or 50%, of what we would inhale at sea level. The same result could be obtained if we were to breathe a gaseous mixture which contained only 10% 02 at sea level. Our goal is not only to remain conscious, but also to be able to think clearly.

In order to provide our bodies with the same amount of 02 we breathe at sea level, we would have to breathe a gas mixture which contains 40% 02. At FL 250, the declining barometric pressure begins to reach a point where even though we present the lungs with an increasing oxygen percentage, there is not enough pressure within the air sacs in our lungs to drive the 02 across the lining of our lungs (alveolar membrane) into our blood stream. This lack of driving pressure starts to become critical above FL 300, necessitating the use of positive pressure breathing systems. These systems, which are frequently used by the U.S.A.F., pump air into our lungs under pressure. The respiratory effort is reversed. We passively inhale and then force the air out of our lungs as we exhale.

11.2 HYPOXIA: This is a state of oxygen deficiency in the body sufficient to impair the function of the brain and other organs. Simply stated, HYPOXIA=STUPIDITY, in that you are too stupid, once you are there. You must save yourself if a problem occurs. Hypoxia begins at about 4,000 feet MSL. This is best illustrated by a progressive loss of your night vision, which begins at this altitude. A decline in your thought processes begins between 8000 – 9000 feet. The amount of 02 actually carried in your body divided by the maximal amount of 02 that you can carry is expressed as your OXYGEN SATURATION. A normal value at sea level would be 97 – 100%. Below 90% oxygen saturation your thought processes begin to unravel. A good mnemonic is that at 9000 feet, you are 90% saturated.

TYPES OF HYPOXIA.

(1) HYPOXIC HYPOXIA: This type of hypoxia is the one with which most pilots are familiar. As we ascend to altitude the amount of 02 in the atmosphere declines. This results in the effects of hypoxia becoming evident as low as 4000 feet (night vision).

(2) ANEMIC HYPOXIA: Oxygen is carried in our blood stream by the red blood cells (RBCs). The RBC's are able to do so because they contain a compound known as hemoglobin (Hb), which acts like a magnet for the 02 molecules. Let us think of the RBC's as boxcars on a freight train. This particular freight train is 10 boxcars long. Each boxcar (RBC) can hold 4 molecules of 02. One trip through the lungs picks up a load of 40 molecules of 02. If we cut the train in half (5 boxcars), we can only pick up 20 molecules of 02 with one passage of the train through the lungs. In this analogy, we are equating boxcars to RBC's. Anemia can be defined as having less than the normal number of RBC's. In an attempt to provide a normal 02 supply, the individual might compensate by pumping the blood volume that is present around twice as fast.

(3) STAGNANT HYPOXIA: This type of hypoxia usually has a normal amount of boxcars in the train. The train makes fewer trips to the lungs to pick up 02. This happens in heart failure. It also happens in the lower part of our bodies, especially our legs, when we have been sitting in the cockpit for prolonged periods of time. In the sitting position forward flow from the heart can be impeded to some extent as if we placed a partial tourniquet around our middle. Our legs are not active while we are sitting in the cockpit. This inactivity prevents the milking action our expanding and contracting muscles have upon the veins in our legs. The result is an accumulation of fluid in our legs, which to some degree can contribute to stagnant hypoxia. Have you ever checked you ankles for swelling after a long cross country at altitude?

(4) HISTOTOXIC HYPOXIA: If the freight train had a normal amount of 02, and was able to reach all the places in our bodies in the normal amount of time, but 02 could not be used once it arrived, we would have histotoxic hypoxia. This condition exists when the enzymes in our cells, which are needed to utilize 02, have been impaired. Cyanide and alcohol are two causes of histotoxic hypoxia.

SYMPTOMS OF HYPOXIA

(a) Change in peripheral vision, even noting "tunnel vision"
Visual acuity impairment; images appear slightly blurred

Difficulty in visual accommodation; focusing from near to distant.
Muscle weakness; more difficult to adjust your seat
Fatigue; uncontrollable sleepiness (not boredom)
Headache-especially if hypoxic for more than 2 hours
Light headedness and mild dizziness; react poorly to turns
Tingling in fingers and toes
Muscular coordination decreased; sloppy at controls
Stammering; can't get the right words out to ATC
Impaired judgment; doing dumb things; slow thinking
Altered respirations; breathing faster and shallower
Delayed reaction time; loss of flying touch
Greatly reduced night vision from 4000 feet
Euphoria; pilot settles for less; who cares?

(b) STAGES OF HYPOXIA

	Blood 02 Saturation	**Symptoms**
(1) Indifferent stage	98%-90%	Decrease in night vision
(2) Compensatory Stage	90%-80%	Drowsiness, poor judgment, impaired coordination and efficiency
(3) Disturbance Stage	80%-70%	Impaired flight control; handwriting, speech and coordination
(4) Critical stage	70%-60%	Circulatory failure plus Cardiovascular collapse;

Nervous system failure Convulsions and DEATH

11.3 CARBON MONOXIDE: This is a silent killer in the cockpit. It is odorless and tasteless. The usual mode of entry is from a leak in the exhaust system via an air vent. Carbon monoxide (CO) has 400 times the affinity for hemoglobin in the RBC when compared to 02. The freight train is full of CO with no room left for 02.

(1) MONITORS.

a. DEAD STOP: Passive discoloration from salmon color to black warns of high levels of CO. It is good for 30 days once it is opened and put to use. Cost=$2.95

b. QUANTUM EYE: Available from most Pilot Supply sources. The principle is the same as dead stop but it is good for 18 months or more. Cost = $10

c. ELECTRONIC MONITORS: Sample the ambient air and sound an alarm and/or provide a digital read out of the CO level. They are usually battery powered, but some can be wired into the electrical system. The cost can vary from $25 to $800. More than adequate models should not cost more than $75. Some examples are "Safe Test 90", and "AIM 395"

Reference: AVIATION CONSUMER, October 2000

11.4 DECOMPRESSON SICKNESS (DCS): It is best demonstrated by my ex-friend Henry. I invited Henry for a ride in my Mooney. He brought along a can of soda which he shook vigorously and at FL 180 he opened it!

(a) HENRY'S LAW. The amount of gas dissolved in a solution is directly proportional to the pressure of the gas over (pressing down upon) the solution.

The atmosphere contains 78% nitrogen. As we ascend in altitude, the pressure outside of our bodies, which keeps the gases in our bodies in the dissolved state, declines and the gases want to bubble and escape.

Above FL 210 (or lower) nitrogen bubbles will escape into the blood stream. If they are carried to our joints we will get the "BENDS". The Bends account for 74% of DCS. The nervous system accounts for 9%, the skin (Creeps) 7%, and the lungs (Chokes) 5% of DCS.

(b)Symptoms of Decompression Sickness

(1) Bends. Joint pain-major joints, mild to severe
(2) Nervous system. Confusion, memory loss, headache, fatigue, seizures, and death.
(3) Skin. Itching, skin feels like it is crawling; parathesias, (numbness and tingling)
(4) Lungs. Dry cough, shortness of breath, chest pain

(c) Increased Risk of Decompression Sickness

(a) Ascend to altitude more rapidly; stay there longer
(b) Increased age and obesity
(c) Exercise
(d) Repeated exposure (2 days in a row)
(e) Scuba diving in the past 24 hours

(d) Treatment of Decompression Sickness

Compression therapy (hyper baric chamber) is the definitive treatment. The longer the delay in treatment, the poorer the outcome.

(e) Decompression Sickness—PREVENTION

(a) Nitrogen washout (breathe 100% 02 for 30 minutes before the flight)
(b) Good hydration

(c) Take one aspirin before the flight
(d) Decrease time at altitude
(e) Slower ascent
(6) Fewer repetitions

11.5 NITROGEN WASHOUT: The replacement of nitrogen within the lungs and thence the body until, theoretically, nitrogen =0% and 02=100%. This of course is not possible but Nitrogen will be substantially reduced. The maximal nitrogen washout may be achieved in as few as 10 minutes. The nitrogen in the blood and tissues is eliminated slowly. Some nitrogen can even enter the blood through your skin.

ARTICLE 2
OXYGEN DELIVERY SYSTEMS

11.6 TYPES OF SYSTEMS.

(a) CONSTANT OR CONTINUOUS FLOW: This type of system is most commonly used in general aviation aircraft. It is a simple system and least likely to malfunction. It is also guilty of wasting large quantities of 02. The system provides the same output, pressure or flow, regardless of the pilot's needs. The source within the aircraft, an oxygen cylinder, when fully charged, will register a pressure of about 2000 pounds per square inch (PSI). A regulator then reduces the pressure to between 37 and 70 PSI. If left unrestricted, the oxygen will typically flow between 2.5 and 3 liters per minute. If a flow meter is being used, opening or closing the valve with a screw restrictor type device can manually adjust the flow meter. Medical regulators usually have a flow meter built into the regulator. These flow meters lack the precision needed in aviation. The exception to this: is the SkyOx system, which combines both a regulator and aviation type flow meter into one unit. Typically, a flow meter is placed down stream from the regulator. A valve is either built into the flow meter (Nelson), or inserted separately (Aerox). The pilot can adjust the flow of 02 appropriately as the pilot changes altitude. The system is therefore ALTITUDE ADJUSTABLE. If this is accomplished by an automatically built in aneroid device, the system is referred to as ALTITUDE COMPENSATING.

(b) DEMAND FLOW: When we breathe, 33% of the time we are inhaling and 67% of the time we are exhaling. A system such as a continuous flow SYSTEM provides 02 flow without regard to the phase of the respiratory cycle thereby wasting 67% of the 02 provided.

A demand system utilizes a sensor to determine when the pilot inhales. This system then selectively delivers a bolus of oxygen only during inhalation. It typically delivers 100% 02 to the pilot. General aviation pilots utilizing nasal cannula including the oxymizer variety (Chad Therapeutics) and masks, inhale cabin air from around these devices along with the 100% 02 provided by the system. The admixture of these gases results in far less than 100% 02 reaching the lungs. When a tight fitting high altitude mask is worn, the 02 system is the sole supply of inhaled gas. Under these circumstances it is not necessary, at moderate altitudes to inhale 100% 02. Air can be quantitatively mixed with the 02 to provide the desired 02 saturation of the inhaled gaseous mixture. When supplied during inspiration only this combination becomes a DILUTER DEMAND system.

(c) PRESSURE DEMAND FLOW: This system is used primarily by the military. Oxygen is delivered under pressure to compensate for the declining barometric pressure. The 02 is delivered during inspiration. The system is expensive and adds significant weight to the aircraft. However, a system such as this may receive serious attention as we see some of the conversions from the Rocket Engineering Company exceeding flight level 300.

11.7 FLOW METERS

(a) EARLY MODELS: The early 02 systems simply had an in-line indicator. This was a simple one-way valve, part of which was colored red, and part green. Without 02 flow, the red part of the indicator was visible through a plastic window. When flow was established, the green part of the indicator became visible as the flow of 02 caused the colored indicator to slide forward beneath the window. This device did nothing to quantitate the amount of 02 that was flowing to the pilot.

(b) NELSON FLOW METER: This flow meter comes in two models the A-3, certified to FL 180, and the A-4, certified to FL 250. As with all flow meters, it is placed in-line in between the regulator atop the 02 cylinder and the pilot. The pilot reads the flow of 02 through a vertical plastic window in the center of the unit. A small ball floats atop the flow of 02. There is a scale on each side of the of the window with which the pilot lines up the ball depending upon which breathing device is being used. The flow of 02 is adjusted by turning a small knob on the side of the unit (Figure 1).The company is now owned by Precise Flight.

(c) AEROX FLOWMETER: This flow meter is basically a Thorpe tube (figure 1). It consists of a clear plastic cylinder with tapered connectors at each end to ease in-line placement. The plastic ball floats atop the flow of 02. There are two scales printed on the tube, corresponding to the two breathing devices available. It must be used with a separate valve in the circuit to control 02 flow.

11.8 BREATHING DEVICES.

(a)NASAL CANNULA: Nasal cannula is very convenient. They allow the pilot to talk, drink, and eat without the interruption of 02. However, be aware that any time you are not breathing through your nose, 02 is not being inhaled. The saying that you "talk until you are blue in the face" applies here. If your nasal passages are blocked due to an anatomic abnormality, or you have an upper-respiratory infection (common cold), you may have difficulty in using a cannula. It is for this reason that the FAA requires a standby facemask in the airplane for each nasal cannula being used.

Without a reservoir, the flow should be set for 1 liter per minute for 10,000 feet MSL. REMEMBER, a nasal cannula may not be used above FL 180.

TYPES OF NASAL CANNULA.

(a) Standard or Medical Cannula. This is the cannula that you see in hospitals. It is made of fairly firm plastic and can become uncomfortable if it is worn for long periods of time. For aviation use it is only recommended in conjunction with the Mountain High System. This cannula lacks any reservoir capacity and the oxygen flow needs to be 1 liter per 10,000 feet of altitude MSL. Because of these high flows this cannula is not recommended for aviation use.

(b) Oxymizer (Oxysaver) Cannula. This nasal cannula contains a reservoir. The reservoir is within the lateral aspect of the nasal cannula or within a pendant that attaches in line to the cannula but hangs around your neck (Figures 2 & 3). The end result is the same. Oxygen accumulates within the reservoir during exhalation. This is 100% 02 as it has not as yet been diluted. When the pilot inhales, the 02 from the reservoir is available as a bolus at the beginning of the inhalation, when 02 is taken deeper into the lungs. We therefore have an inexpensive diluter demand type system. In your nose, throat, pharynx and connecting air tubes, the oxygen is diluted with "used" air as it makes its way to your lungs. The Oxysaver has two advantages. First it provides a higher 02 supply at a lower flow, thereby conserving the 02 supply
(Table 1). If used correctly it will result in a 75% savings. Secondly, the Oxysaver is made of soft plastic and its weight is distributed over a larger surface on the pilot's face making it more comfortable to wear.

MASK: A mask is required to be worn above FL 180.

(1) Types of masks.

(a) Standard Hospital Mask. This mask is more effective than a standard hospital nasal cannula. It may not be used above FL 180. It lacks a reservoir and requires a greater 02 flow.

(b) Partial Re-breather Mask: This mask resembles a standard hospital mask with the exception that it contains a plastic bag, which collects air that you exhale. Your exhaled air is still very rich in 02. Rather than waste it, you re-breathe it. The amount of carbon dioxide inhaled with this mask is not significant. Much higher saturations are possible (Figure 4B). These masks are available with built in microphones in order to avoid removing them in order to talk to ATC. Masks with microphones are available from Scott and Aerox. A partial re-breather mask is required above FL 180.

(c) Sequential Re-breather Mask: This mask has a built in check valve that allows the induction of 02 and cabin air. The mask itself fits tightly so that the only cabin air that is admitted is through the check valve.

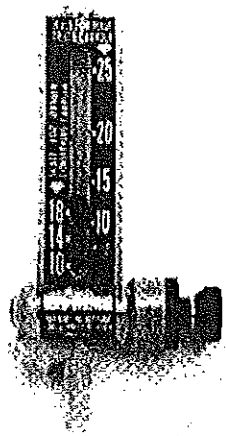
11.9 EFFICIENCY OF OXYGEN DELIVERY SYSTEMS: The flow of 02 is not great enough to supply all of our inspired air. This means that cabin air is inhaled as well, which dilutes the concentration of 02 on the way to our lungs. The following is a comparison of the percentage of 02 one can receive using the different cannula and masks.

(a) TYPES OF OXYGEN DELIVERY SYSTEMS	**Percentage of O2 Delivered**
None at sea level	21%
Nasal Cannula (standard)	44%
Nasal Cannula (oxysaver)	44%
Oxygen Mask (non re-breather)	60%
Oxygen mask with reservoir (re-breather)	99%

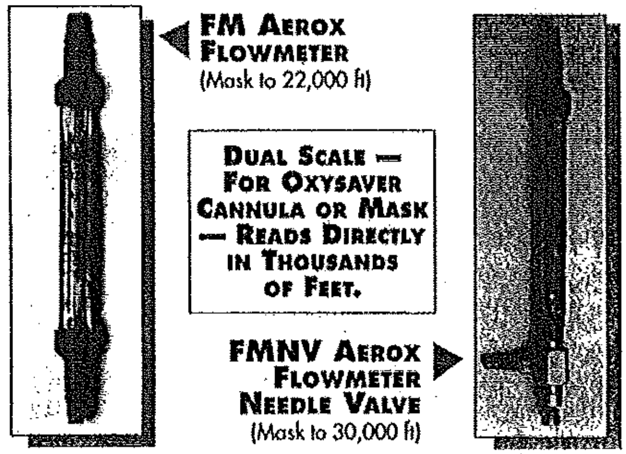
11.10 Pulse Oximetry It is a method of measuring the percent of 02 within the blood. The amount of 02 carried within the RBC's divided by the maximum amount, which can be carried, which is 100%. A beam of light is projected into the skin or nail bed. The reflectance beam's wavelength corresponds to the percent of 02 saturation. This extrapolation is possible because as more 02 is carried, the hemoglobin within the RBC's becomes redder. With less and less 02 the hemoglobin becomes progressively bluer.

The recorded wavelength is reported as percent 02 saturation. A reading may be taken from a finger, ear lobe, or directly through the skin. The FlightStat by Nonin is currently enjoying wide use in the Mooney Fleet. (Figures 4C&5) We are currently testing a sensor, which is attached to the forehead like a band-aid. It is attached through the intercom. When the 02 saturation drops below 90%, a woman's voice alerts the pilot. A business card size graphic monitor is attached to the panel for visual verification (Ox-Alert by Aircraft Components, Inc.).

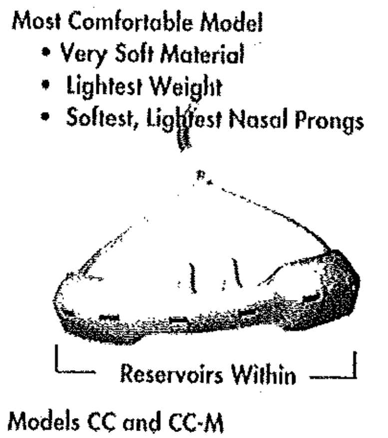
Figure 1



NELSON


FM Aerox Flowmeter
(Mask to 22,000 ft)
Dual Scale — For Oxysaver Cannula or Mask — Reads Directly in Thousands of Feet.
FMNV Aerox Flowmeter Needle Valve
(Mask to 30,000 ft)

OXIMISER NASAL CANNULA



Oxysaver Cannula by Chad

Figure 3

PENDANT CANNULA

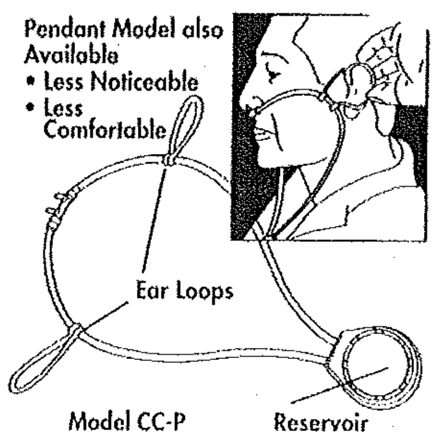
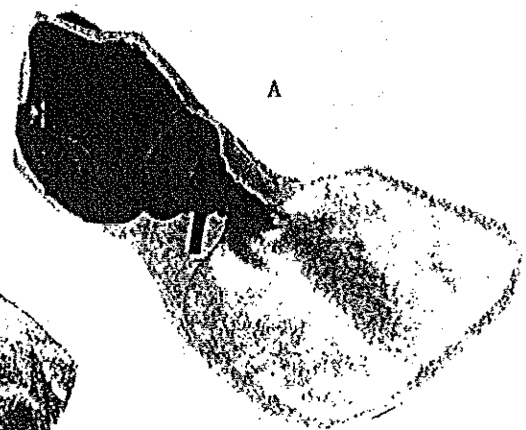


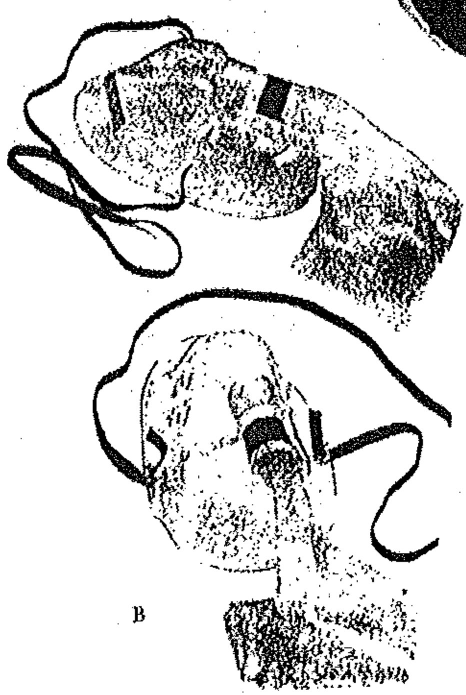
Figure 4

A. HIGH ALTITUDE CHAMBER
DEMAND DILUTER MASK WITH
POSITIVE PRESSURE MODE
B. REBREATHER MASK (REQUIRED ABOVE
FL 180)
C. Fingertip Pulse oximeter

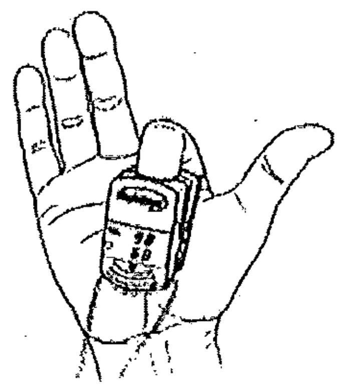
A



A



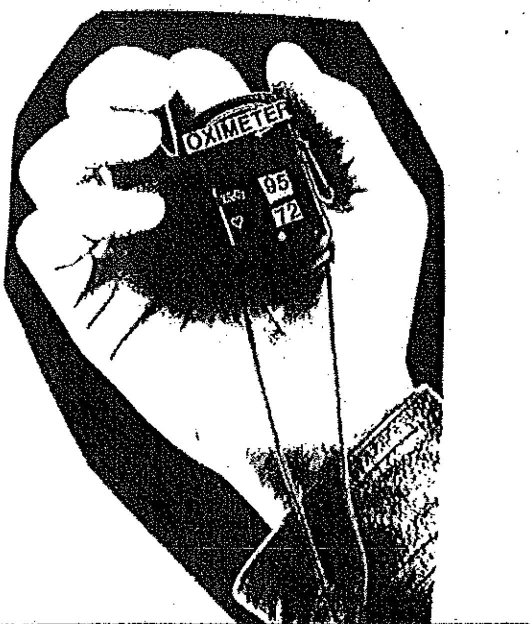
B



C

Fly Smart

Figure 5



The Pulse Oximeter provides an easy and accurate way to check for in-flight hypoxia by monitoring the blood oxygen saturation and pulse rate. This unit, combined with understanding the symptoms of hypoxia, can make a difference for detecting the early on-set of hypoxia - before it affects your performance.

Just follow the 2-STEP METHOD to protect yourself from the onset of hypoxia.

Know the Symptoms and Signs of Hypoxia

You may not even recognize the signs and symptoms of hypoxia. In most cases, hypoxia is subtle in its onset and may go undetected. The signs and symptoms can be different for every person and may not occur in the same progression; therefore it is important to be aware of the symptoms.

Signs	Symptoms
Rapid Breathing	Air Hunger
Cyanosis	Dizziness
Poor Coordination	Headache
Lethargy/Lassitude	Mental and Muscle Fatigue
Executing Poor Judgement	Nausea
	Hot and Cold Flashes
	Tingling
	Visual Impairment
	Euphoria

"Aviation Physiology," Federal Aviation Administration Civil Aeromedical Institute, Oklahoma City, OK

When flying at high altitudes, hypoxia can impair your cognitive functions limiting your ability to read, reason, think, see and even talk - all necessary to fly your plane and your passengers safely.

Depending on your age, overall health condition, etc. - symptoms associated with hypoxia can occur as low as 5,000 feet.

Blood Oxygen Saturation By Altitude

Altitude (feet)	Arterial O_2 Saturation Without Supplemental O_2	Atmospheric Pressure (mmHg)
0	96%	760
5,000	95%	632
7,500	93%	575
10,000	89%	523
12,500	87%	474
14,000	83%	446
16,500	77%	403
20,000	65%	349
25,000	Below 60%	282

"The Pilot: An Air Breathing Mammal," Mohler, Stanley R. MD, Human Factors Bulletin, Flight Safety Foundation, 1981

Table 1

Duration* Chart for Systems Using Oxysaver Cannulas

	10,000 Ft. (MSL)					15,000 Ft. (MSL)					18,000 Ft. (MSL)				
Cylinder Size	A 180L 6CF	C 240L 9CF	D 400L 13CF	E-M 700L 22CF	F 1000L 33CF	A 180L 6CF	C 240L 9CF	D 400L 13CF	E-M 700L 22CF	F 1000L 33CF	A 180L 6CF	C 240L 9CF	D 400L 13CF	E-M 700L 22CF	F 1000L 33CF
Users	Hours of use					Hours of use					Hours of use				
1	12.0	16.0	26.7	46.7	66.7	6.7	8.9	14.8	25.9	37.0	4.6	6.2	10.3	17.9	25.6
2	6.0	8.0	13.3	23.3	33.3	3.3	4.4	7.4	13.0	18.5	2.3	3.1	5.1	9.0	12.8
3	4.0	5.3	8.9	15.6	22.2	2.2	3.0	4.9	8.6	12.3	1.5	2.1	3.4	6.0	8.5
4	3.0	4.0	6.7	11.7	16.7	1.7	2.2	3.7	6.5	9.3	1.2	1.5	2.6	4.5	6.4
5	2.4	3.2	5.3	9.3	13.3	1.3	1.8	3.0	5.2	7.4	0.9	1.2	2.1	3.6	5.1
6	2.0	2.7	4.4	7.8	11.1	1.1	1.5	2.5	4.3	6.2	0.8	1.0	1.7	3.0	4.3

*Approximate

Flight — The Impact of Altitude

Know the Symptoms and Signs of Hypoxia

You may not even recognize the signs and symptoms of hypoxia. In most cases, hypoxia is subtle in its onset and may go undetected. The signs and symptoms can be different for every person and may not occur in the same progression; therefore, it is important to be aware of the symptoms.

Signs	Symptoms
Rapid Breathing	Air Hunger
Cyanosis	Dizziness
Poor Coordination	Headache
Lethargy/Lassitude	Mental and Muscle Fatigue
Executing Poor Judgement	Nausea
	Hot and Cold Flashes
	Tingling
	Visual Impairment
	Euphoria

"Aviation Physiology," Federal Aviation Administration, Civil Aeromedical Institute, Oklahoma City, OK.

One of the most important effects of hypoxia is decreased mental proficiency which decreases judgment, memory, and the performance of discrete motor movements. For instance, if an unacclimatized aviator stays at 15,000 feet for 1 hour, mental proficiency ordinarily will have fallen to about 50% of normal and after 18 hours at this level to about 20% of normal.

Know the Effects of Altitude

When flying at high altitudes, hypoxia can impair your cognitive functions limiting your ability to read, reason, think, see and even talk - all necessary to fly your plane and your passengers safely.

Blood Oxygen Saturation By Altitude

Altitude (feet)	Arterial O_2 Saturation Without Supplemental O_2	Atmospheric Pressure (mmHg)
0	[illegible]	760
5,000	95%	632
7,500	93%	575
10,000	89%	523
12,500	87%	474
14,000	83%	446
16,500	77%	403
20,000	65%	349
25,000	Below 60%	282

"The Pilot An Air Breathing Mammal," Mohler, Stanley R. MD, Human Factors Bulletin, Flight Safety Foundation, 1981.

Depending on your age, overall health condition, etc. - symptoms associated with hypoxia can occur as low as 5,000 feet. The table on the left indicates some common signs and symptoms of in-flight hypoxia.

Addendum 2

Flight Resources

Listed below are a number of resources to provide additional information on altitude-induced hypoxia.

1. "Altitude Problems," Adkins, Carrie L., Advance For Managers of Respiratory Care, March 1998.
2. "Aviation, High Altitude and Space Physiology," Textbook of Medical Physiology, Guyton, Arthur C., Hall, John E, Ph.D., WB Saunders Company, 1996.
3. "Aviation Physiology," Federal Aviation Administration, Civil Aeromedical Institute, Oklahoma City, OK, 1998.
4. "Breathe Easier, Pulse Oximeter Detects Hypoxia Your Brain Doesn't Recognize and Helps Get More Mileage Out of Supplemental Oxygen Tanks," Chien, Bruce, MD, Aviation Safety, February 2000.
5. "Effects of Mild Hypoxia on Pilot Performances at General Aviation Altitudes," Nesthus, Thomas E., Rush, Ladonna, L., Wreggit, Steven S., Federal Aviation Administration, Civil Aeromedical Institute, Oklahoma City, OK, 1997.
6. "How Much Oxygen is Enough? Ask the Pulse Oximeter," Achtel, Robert, MD, MAPA Log, August 1998.
7. "Hypoxia: An Insidious Killer, How Pilots Can Combat the Subtle But Lethal Effects of Oxygen Deprivation," Patiky, Mark, Aviation Safety, August 1993.
8. "Hypoxia! How to Recognize and Defeat It," Benenson, Tom, Flying, May 1993.
9. "The Pilot: An Air Breathing Mammal," Mohler, Stanley R., MD, Human Factors Bulletin, Flight Safety Foundation, 1981.
10. "Quick Response by Pilots Remains Key to Surviving Cabin Decompression," Mohler, Stanley R., MD, Human Factors and Aviation Medicine, Flight Safety Foundation, 2000.
11. "When Humans Fly High: What Pilots Should Know About High-Altitude Physiology, Hypoxia and Rapid Decompression," Pendleton, Linda D., www.avweb.com/articles/highalt.

NOTES:

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MOONEY AIRCRAFT PRODUCTION HISTORY

MOONEY AIRCRAFT CHRONOLOGY

Mooney
Aircraft
Pilots
Association
Safety Foundation

MOONEY AIRCRAFT

The Personal Airliner

PRODUCTION HISTORY OF THE MOONEY AIRCRAFT

YEAR	MODEL	NAME	S/N RANGE	ENGINE/AIRCRAFT DESCRIPTION	TOT
1949	M18L	Mite	2 - 67	LYC O-145-B2 (1 place)	66
1950	M18L	Mite	68 - 82	LYC O-145-B2 (1 place)	15
1950	M18C	Mite	201 - 240	CONT A65-12 or -8 (1 place)	40
1951	M18LA	Mite	101 - 114	LYC O-145-B2 (1 place)	14
1951	M18C	Mite	241 - 249	CONT A65-12 or -8 (1 place)	9
1952	M18LA	Mite	115 - 135	LYC O-145-B2 (1 place)	21
1952	M18C	Mite	250 - 277	CONT A65-12 or -8 (1 place)	28
1953	M18LA	Mite	136 - 145	LYC O-145-B2 (1 place)	10
1953	M18C	Mite	278 - 299	CONT A65-12 or -8 (1 place)	22
1951	M18C	Mite	300 - 322	CONT A65-12 or -8 (1 place)	23
1955	M18C55	Mite	323 - 357	CONT A65-12 or -8 (1 place)	35
1955	M20	Mark 20	1001 - 1010	LYC O-320 (150hp-4 place)	10
1956	M20	Mark 20	1011 - 1061	LYC O-320 (150hp-4 place)	51
1957	M20	Mark 20	1062 - 1166	LYC O-320 (150hp-4 place)	105
1958	M20	Mark 20	1167 - 1200	LYC O-320 (150hp-4 place)	34
1958	M20A	Mark 20A	1201 - 1303	LYC O-360-A1A or D (180hp-4 place)	103
1959	M20A	Mark 20A	1304 - 1534	LYC O-360-A1A or D (180hp-4 place)	231
1960	M20A	Mark 20A	1535 - 1700	LYC O-360-A1A or D (180hp-4 place)	165
In 1961 Mooney converted from wood/fabric/metal to all metal construction.					
1961	M20B	Mark 21	1701 - 1924	LYC O-360-A1A or D (180hp-all metal)	223
1962	M20C	Mark 21	1940 - 2276	LYC O-360-A1D (180hp-all metal)	336
1963	M20C	Mark 21	2297 - 2622	LYC O-360-A1D (180hp-all metal)	328
1963	M20D	Master	101 - 200	LYC O-360-A1D or A2D (fixed gear)	100
1964	M20C	Mark 21	2623 - 2806	LYC O-360-A1D (180hp-all metal)	183
1964	M20D	Master	201 - 251	LYC O-360-A1D or A2D (fixed gear)	51
1964	M20E	Super 21	101 - 469	LYC IO-360-A1A (200hp)	366
1965	M20C	Mark 21	2807 - 3184	LYC O-360-A1D (180hp)	379
1965	M20D	Master	251 - 259	LYC O-360-A1D or A2D (fixed gear)	8
1965	M20E	Super 21	470 - 831	LYC IO-360-A1A (200hp)	363
1966	M20C	Mark 21	3185 - 3466	LYC O-360-A1D (180hp)	280
1966	M20D	Master	260 only	LYC O-360-A1D or A2D (fixed gear)	1
1966	M20E	Super 21	832 - 1308	LYC IO-360-A1A (200hp)	473
1966	M20F	Executive	660001 - 660003	LYC IO-360-A1A (200hp-long cabin)	3
1966	M22	Mustang	660004 - 660006	LYC TIO-541-A1A (310hp-pressurized)	3
1967	M20C	Mark 21	670001 - 670149	LYC O-360-A1D (180hp)	147
1967	M20E	Super 21	670001 - 670062	LYC IO-360-A1A (200hp-short cabin)	62
1967	M20F	Executive	670001 - 670539	LYC IO-360-A1A (200hp-long cabin)	536
1967	M22	Mustang	670001 - 670004	LYC TIO-541-A1A (310hp-pressurized)	4
1968	A2-A	Cadet	B-261 - B-298	CONT C90-16F (90hp-2 place)	38
1968	M20C	Ranger	680001 - 680198	LYC O-360-A1D (180hp)	196
1968	M20F	Executive	680001 - 680206	LYC IO-360-A1A (200hp-long cabin)	206
1968	M20G	Statesman	680001 - 680164	LYC O-360-A1D (180hp-long cabin)	164
1968	M22	Mustang	680001 - 680015	LYC TIO-541-A1A (310hp-pressurized)	15
1969	M10	Cadet	690003 - 690011	CONT C90-16F (90hp-2 place	9
1969	M20C	Ranger	690001 - 690098	LYC O-360-A1D (180hp)	98
1969	M20E	Chaparral	690001 - 690073	LYC IO-360-A1A (200hp-short cabin)	73
1969	M20F	Executive	690003 - 690092	LYC IO-360-A1A (200hp-long cabin)	91
1969	M20G	Statesman	690001 - 690020	LYC O-360-A1D (180hp-long cabin)	20
1969	M22	Mustang	690001 - 690005	LYC TIO-541-A1A (310hp-pressurized)	5
1970	M10	Cadet	700001 - 700050	CONT C90-16F (90hp-2 place)	50
1970	M20C	Ranger	700001 - 700091	LYC O-360-A1D (180hp)	88
1970	M20E	Chaparral	700001 - 700061	LYC IO-360-A1A (200hp-short cabin)	54
1970	M20F	Executive	700001 - 700072	LYC IO-360-A1A (200hp-long cabin)	68
1970	M20G	Statesman	700001 - 700006	LYC O-360-A1D (180hp-long cabin)	6
1970	M22	Mustang	700001 - 700006	LYC TIO-541-A1A (310hp-pressurized)	6
1971	M20C	Ranger	20-0001 - 20-0009	LYC O-360-A1D (180hp)	9
1971	M20E	Chaparral	21-0001 - 21-0023	LYC IO-360-A1A (200hp-short cabin)	23
1971	M20F	Executive	22-0001 - 22-0012	LYC IO-360-A1A (200hp-long cabin)	12
Republic Steel bought Mooney from Butler Aviation Oct 73. Production resumed Jan 74					
1974	M20C	Ranger	20-0010 - 20-0046	LYC O-360-A1D (180hp)	37
1974	M20E	Chaparral	21-0024 - 21-0060	LYC IO-360-A1A (200hp-short cabin)	37
1974	M20F	Executive	22-0013 - 22-0078	LYC IO-360-A1A (200hp-long cabin)	66
1975	M20C	Ranger	20-1147 - 20-1185	LYC O-360-A1D (180hp)	39
1975	M20E	Chaparral	21-1161 - 21-1180	LYC IO-360-A1A (200hp-short cabin)	20
1975	M20F	Executive	22-1179 - 22-1305	LYC IO-360-A1A (200hp-long cabin)	127
1976	M20C	Ranger	20-1186 - 20-1218	LYC O-360-A1D (180hp)	33
1976	M20F	Executive	22-1306 - 22-1432	LYC IO-360-A1A (200hp-long cabin)	127
1977	M20C	Ranger	20-1219 - 20-1243	LYC O-360-A1D (180hp)	25

YEAR	MODEL	NAME	S/N RANGE	ENGINE/AIRCRAFT DESCRIPTION	TOT
1977	M20F	Executive	22-1433 - 22-1439	LYC IO-360-A1A (200hp-long cabin)	7
1977	M20J	201	24-0001 - 24-0377	LYC IO-360-A3B6D (200hp-long cabin)	377
1978	M20C	Ranger	20-1244 - 20-1258	LYC O-360-A1D (180hp)	15
1978	M20J	201	24-0378 - 24-0757	LYC IO-360-A3B6D (200hp-long cabin)	380
1979	M20J	201	24-0764 - 24-0900	LYC IO-360-A3B6D (200hp-long cabin)	137
1979	M20K	231	25-0001 - 25-0246	CONT TSIO-360-GB1 (210hp-long cabin)	246
1980	M20J	201	24-0901 - 24-1037	LYC IO-360-A3B6D (200hp-long cabin)	137
1980	M20K	231	25-0247 - 25-0446	CONT TSIO-360-GB1 (210hp-long cabin)	200
1981	M20J	201	24-1038 - 24-1213	LYC IO-360-A3B6D (200hp-long cabin)	176
1981	M20K	231	25-0447 - 25-0612	CONT TSIO-360-GB1 (210hp-long cabin)	166
1982	M20J	201	24-1214 - 24-1326	LYC IO-360-A3B6D (200hp-long cabin)	113
1982	M20K	231	25-0613 - 25-0717	CONT TSIO-360-GB4 (210hp-long cabin)	105
1983	M20J	201	24-1327 - 24-1417	LYC IO-360-A3B6D (200hp-long cabin)	91
1983	M20K	231	25-0718 - 25-0780	CONT TSIO-360-GB4 (210hp-long cabin)	63
1984	M20J	201	24-1418 - 24-1499	LYC IO-360-A3B6D (200hp-long cabin)	87
1984	M20K	231	25-0781 - 25-0841	CONT TSIO-360-LB1 (210hp-long cabin)	61
1985	M20J	201	24-1500 - 24-1550	LYC IO-360-A3B6D (200hp-long cabin)	51
1985	M20K	231	25-0842 - 25-0889	CONT TSIO-360-LB1 (210hp-long cabin)	48
1986	M20J	201	24-1551 - 24-1588	LYC IO-360-A3B6D (200hp-long cabin)	38
1986	M20K	252	25-1000 - 25-1066	CONT TSIO-360-MB1 (210hp-long cabin)	67
1987	M20J	205	24-3000 - 24-3056	LYC IO-360-A3B6D (200hp-long cabin)	57
1987	M20J	201 (LM)	24-1589 - 24-1641	LYC IO-360-A3B6D (200hp-long cabin)	53
1987	M20K	252	25-1067 - 25-1157	CONT TSIO-360-MB1 (210hp-long cabin)	91
1988	M20J	205	24-3057 - 24-3078	LYC IO-360-A3B6D (200hp-long cabin)	22
1988	M20J	201 (LM)	24-1642 - 24-1685	LYC IO-360-A3B6D (200hp-long cabin)	44
1988	M20K	252	25-1158 - 25-1198	CONT TSIO-360-MB1 (210hp-long cabin)	41
1988	M20L	PFM	26-0001 - 26-0040	Porsche 3200-NO3 (217hp-longer cabin)	40
1989	M20J	AT	24-1686 only	LYC IO-360-A3B6D (200hp-long cabin)	1
1989	M20J	201	24-3079 - 24-3143	LYC IO-360-A3B6D (200hp-long cabin)	65
1989	M20K	252	25-1199 - 25-1220	CONT TSIO-360-MB1 (210hp-long cabin)	22
1989	M20L	PFM	26-0041 only	Porsche 3200-NO3 (217hp-longer cabin)	1
1989	M20M	TLS	27-0001 - 27-0035	LYC TIO-540-AF1A (270hp-longer cabin)	35
1990	M20J	AT	24-1687 - 24-1706	LYC IO-360-A3B6D (200hp-long cabin)	20
1990	M20J	201	24-3144 - 24-3207	LYC IO-360-A3B6D (200hp-long cabin)	64
1990	M20K	252	25-1221 - 25-1230	CONT TSIO-360-MB1 (210hp-long cabin)	10
1990	M20L	PFM	26-0042 only	Porsche 3200-NO3 (217hp-longer cabin)	1
1990	M20M	TLS	27-0036 - 27-0084	LYC TIO-540-AFIA (270hp-longer cabin)	49
1991	M20J	201	24-3208 - 24-3245	LYC IO-360-A3B6D (200hp-long cabin)	38
1991	M20M	TLS	27-0085 - 27-0125	LYC TIO-540-AFIA (270hp-longer cabin)	41
1992	M20J	MSE	24-3246 - 24-3286	LYC IO-360-A3B6D (200hp-long cabin)	41
1992	M20M	TLS	27-0126 - 27-0146	LYC TIO-540-AFIA (270hp-longer cabin)	21
1993	M20J	MSE	24-3287 - 24-3320	LYC IO-360-A3B6D (200hp-long cabin)	34
1993	M20M	TLS	27-0147 - 27-0146	LYC TIO-540-AFIA (270hp-longer cabin)	27
1994	M20J	MSE	24-3321 - 24-3354	LYC IO-360-A3B6D (200hp)	34
1994	M20M	TLS	27-0174 - 27-0193	LYC TI0540-AFIA (opt. AFIB, 270hp)	19
1994	M20R	Ovation	29-0001 - 29-0021	TCM IO-550-G (280hp)	21
1995	M20J	MSE	24-3355 - 24-3373	LYC IO-360-A3B6D (200hp)	19
1995	M20M	TLS	27-0194 - 27-0208	LYC TIO-540-AFIA (opt.AFIB)	15
1995	M20R	Ovation	29-0022 - 29-0075	TCM IO-550-G (280hp)	54
1996	M20J	MSE	24-3374 - 24-3393	LYC IO-360-A3B6D (200hp)	20
1996	M20M	TLS	27-0209 - 27-220	TIO540-AFIA (-0209 & 0210)(AFIB-0211&on)	12
1996	M20R	Ovation	29-0076 - 29-0095	TCM IO-550-G (280hp)	20
1997	M20K	252	25-2001 - 25-2008	TCM TIO-360-MB1 (210hp)	8
1997	M20K	Encore	25-2009 - 25-2017	TCM TIO-360-SB2 (220hp)	9
1997	M20M	Bravo TLS	27-0221 - 27-0240	LYC TIO-540-AFIB (270hp)	20
1997	M20R	Ovation	29-0096 - 29-0131	TMC IO-550-G (280hp)	36
1997	M20J	MSE	24-3394 - 24-3412	IO-360-A3B6 (200hp)	19
1998	M20J	Allegro	24-3413 – 24-3431	LYC IO-360-A3B6 (200 hp)	19
1998	M20R	Ovation	29-0132 – 29-0172	TCM IO-550-G (280 hp)	41
1998	M20K	Encore	25-2018 – 25-2035	TCM TIO-360-SB2 (220 hp)	18
1998	M20M	TLS Bravo	27-0240 – 27-0256	LYC TIO-540-AFIB (270 hp)	17
1999	M20R	Ovation	29-0173 – 29-0199	TCM IO-550-G (280 hp)	27
1999	M20M	TLS Bravo	27-0257 – 27-0281	LYC TIO-540-AFIB (270 hp)	25
1999	M20S	Eagle	30-0001 – 30-0039	TCM-IO-550-G (244 hp)	39
2000	M20R	Ovation2	29-0200 – 29-0269 excluding 29-0260 and 29-0268	TCM IO-550-G (280 hp)	55
2000	M20M	TLS Bravo	27-0282 – 27-0310 excluding 27-0304	LYC TIO-540-AFIB (270 hp)	26
2000	M20S	Eagle	30-0040 – 30-0055 +30-0057	TCM IO-550-G (244 hp)	19
2001	M20R	Ovation2	29-0260, -0268 & 29-0270 – 29-0279	TCM IO-550-G (280 hp)	12
2001	M20M	TLS Bravo	27-0304, 27-0311 -27-0316	LYC TIO-540-AFIB (270 hp)	7
2001	M20S	Eagle2	30-0056, 30-0058 -30-0062	TCM-IO-550-G (244 hp)	6