TIPS – Chapter One
Flight Performance

Table of Contents

LEANING

Advantages of proper leaning:

Economy, increased range, more engine power with increased airspeed, smoother engine operation, more normal engine temperatures, and helps prevent spark plug fouling.

Best Sources of Leaning Information:
1. Avco Lycoming Service Instruction No. 1094
2. Airplane Owner's Manual.
3. Engine Operator's Manual.
4. A proper flight checkout by a competent instructor pilot.

Basic Leaning, Direct Drive Engines:
At 75% power or less the engine may be leaned anywhere as desired and at any altitude as long as the engine operates smoothly, and temperatures and pressures are within limits.

Use of more than 75% power: Improper leaning can result in engine damage. When in doubt use full rich mixture above 75% power, otherwise carefully follow these steps for correct cruise leaning:
1. Establish 75% cruise power and lean to peak EGT or TIT without exceeding 1650 deg. F. on TIT;
2. Reduce temperature 125 deg. F. below peak EGT by enriching at 75% power and mark this position on the EGT or TIT gauge;
3. Return mixture control to rich position and increase RPM and MP to desired higher power;
4. Lean out mixture until EGT or TIT is at value established in Step 2 above.

Monitor cylinder head temperature. Do not lean to peak EGT above 75% power.

Takeoff and climb below 5,000 feet, use full rich mixture through 5,000 feet with an non-turbocharged engine, for continued climb lean mixture not for economy by only for smooth engine operation.

Carburated powerplants:
At cruise power of 75% or less, use age-old procedure of leaning until engine roughens, then enrich slightly until engine is smooth. If engine roughens during use of carburetor heat at cruise, adjust mixture leaner for smooth engine operation.Fuel Injected Powerplants:

Observe fuel flow gauge as a general reference for leaning, use exhaust gas temperature gauge for specific leaning reference, cross check cylinder head temperature gauge. If these instruments are not available, limit power for cruise to 75% and lean until engine roughens or loses power, then enrich for smooth operation.

The Turbocharged Powerplant:
The Turbine Inlet Temperature Gauge; is a required instrument with turbocharging. When leaning, the TIT must not exceed the red line temperature of 1650 deg. F. (900 deg. C.). During cruise operation and leaning the mixture, if TIT reached 1650 deg. F. before peaking then do not exceed the red line temperature. Use full rich mixture for climb unless the airframe Owner's Manual states otherwise. *For details see S.I. No.1094 and the Airplane Owner's Manual for Engine Operator's Manual.

GENERAL INFORMATION

1. For maximum service life, maintain cylinder head temperature below 435 deg. F. during high performance cruise operation, and below 400 deg. F. for economy cruise power.
2. Definitions:
   - High performance cruise power-more than 75% power on direct drive engines, and more than 65% power on supercharged powerplants.
   - Economy cruise power - 75% power or less on direct drive engines, and 65% power or less on geared or supercharged engines.
   - Maximum power range mixture - leaned generally 75 deg. to 125 deg. on the rich side of peak EGT.
   - Best power mixture - the leanest mixture strength which produces the highest indicated airspeed for any given engine speed and manifold pressure.
   - Best economy range mixture - leaned to peak EGT or approximately 10 deg. F. to the lean side of peak. On those engines without an EGT, it is the leanest mixture position without roughness with a slight loss in cruise airs.

LEANING BELOW 5000 FEET

We at Lycoming were shocked to see the following in one of the best aviation magazines in the business. "Here are a couple of 100 octane operating tips that pilots should be aware of when using 100 octane in 80 octane engines. One is a recommendation to lean the mixture at all cruising altitudes, not just those above 5,000 feet msl as commonly taught."

The above statement in print dated August 1976, is discouraging to us because we have been stressing this aspect of leaning for years. Engines normally aspirated (not supercharged or turbocharged) should be leaned at any altitude when operating at the manufacturers' recommended cruise power. Along with this recommendation, we have consistently clarified the misunderstanding concerning leaning and the 5,000 ft. reference point for normally aspirated powerplants. We explain it by stating that engines in this category in climb anywhere from sea level through 5,000 ft. density altitude should normally be at full rich mixture. Continued climb above the 5,000 ft. reference point permits leaning to a smooth engine.

As a result of the latter explanation many pilots erroneously assumed leaning was not permitted below 5,000 feet altitude. We have been explaining all of this for years, so we find it incredible that a leading aviation magazine would infer that it had just discovered a helpful secret - that of leaning at cruise below 5000 ft. (From the Avco Lycoming "Flyer")

LEANING

Remember the old rule of thumb for leaning the engine if you have no EGT. Lean it out until it runs rough and then richen it until the roughness goes away and then a little bit more. If you do this, watch the tachometer after a few minutes. If the tachometer is wandering, surging, hunting ever so slightly, it is likely that the engine is not richened enough and one or more cylinders are trying to run but are not quite making it to full power all the time. This situation will cause the prop governor to try to continually adjust the pitch to compensate for the rapid fluctuations in engine output power. If everything appears normal in the EGT and fuel flow department, tachometer fluctuations of a small amount can be the first warning signals of impending fuel injector contamination or fuel flow problems. Of course the prop governor could be going bad too but don't jump to the conclusion that the governor is automatically bad. It might be doing just what it was designed to do and be doing it very well. Watch for the little hints.

LEANING

Q. How should I lean the mixture before takeoff at a high elevation field?

A. I would set the brakes and apply full power. Then lean as you would in flight. If you have an EGT you can use it, or you can lean until the engine begins to run rough and then back off until it runs smooth-out. This should be done before you begin the takeoff run, because there is too much to do afterward.

ENGINE FAILURE, FROZEN FUEL LINE

Our twin Comanche has been in the family for about 8 years and my children have used it to obtain their Instrument ratings.

Recently my daughter had the misfortune to have a double engine failure which resulted in an off field landing and major damage to the aircraft.

On a trip prior to the accident flight she had been with her instructor when the aux tanks were selected an engine misfire occurred. The misfire was due to ice in the aux tank lines to the fuel selector. The main tanks were reselected and the flight was competed without further problems. The aircraft was sent to the maintenance shop for repair, however through a misunderstanding the aux lines were not repaired.

A week later she is on another flight when the same thing happens when the aux tanks are selected. She reselects the mains and continues the flight flight knowing from previous flights that the flight can be completed on the main tanks. However due to the fact that she had never refuelled the plane herself she did not know that with the mains fuelled to the bottom of the filler neck that the mains are not full. Crossing the outer marker the left engine failed, she completed her emergency drills and continued the approach. At the final fix the right engine failed resulting in a heavy landing just short of the airport.
Two things can be learned here.

1. The mains are not full when fuel only reaches to the bollotmm of the filler neck, they need to be filled to the top of the neck.
2. The fuel selector and filter need to be serviced and checked for water when the aircraft is serviced, especially when operating in clod climates.

TWIN FUEL SELECTOR VALVE ICE

(100 hour inspection mandates)
The subsequent information, however, is I think of major interest to Twin Comanche flyers. The FAA investigation by the FAA engineer with Milwaukee office showed that the fuel valves were full of ice and that fuel would not drain from the auxiliary tanks. In the winter it is impossible if an airplane is stored in a cold area to remove any ice crystals that may accumulate in that fuel system and the Milwaukee office forwarded to the National Transportation Safety Board a full report. They recommended further engineering evaluations as to a possible valve defect. In talking with one of the investigators at Milwaukee, he suggested that I contact the chief engineer at Piper and have a discussion with him about this possible deficiency, which I did do. The chief engineer advised that he would pursue this information and determine if any corrective action should be taken. I subsequently found from a conversation with a business associate to whom I had leased the airplane four years ago for a period of a year of air freight work that he had had an even more severe condition over Lake Michigan during the winter in that he had a complete

right engine shut down because of ice accumulation in the valve. He had the valves completely reworked and both valves replaced.

It appears that since all four tanks drain into the valve for sump draining then any ice accumulation in the tank would therefore be drawn into the screens of the valving system. After the accident I found that a friend of mine who owns a Twin Comanche always had his maintenance man completely disassemble the bottom of the valve for cleaning before winter sets in to make certain there is no accumulated dirt or material in the valve.

I would strongly recommend that anyone flying a Twin Comanche carefully maintain the valving system in its present form during the winter months and it would be my sincere hope that some sort of an improvement could be derived to prevent such a condition as developed on my Twin.

ENGINE AIR START

Q. The handbook for my 260B (fuel injection) does not give procedures for air starts if you run a tank dry. What is a procedure?

A. As long as you maintain a glide speed the propeller will windmill and keep the engine turning. I suggest the following procedure:
Reduce the throttle to about 1/4 throttle. The purpose of this is to eliminate excessive engine surge when the engine "catches". Select a tank with fuel. Turn on the electric boost pump. This will push fuel into the engine sooner. Since it is windmilling, it will be able to handle the fuel being fed to it. After the engine starts, gradually apply power. Remember, the engine has been rapidly cooled - don't try to rapidly heat it by applying full throttle, do it very gradually. LYCOMING says to avoid letting an engine run dry because of the rapid cooling can cause cylinders to crack.

LANDING WITH ELECTRIC FUEL PUMP ON

Q. My handbook recommends the aux. pump on for landing. What's the reason? Is there any danger of dropping RPM when sudden power is added because of the over rich mixture, or even momentary power failure when you apply full power?

A. The purpose of the aux. or electric boost pump is to provide backup in the event the engine driven pump fails. Obviously, you don't want to have to cope with that problem during a take-off or landing. It will not provide an over rich mixture. That is the purpose of the mixture control and the fuel metering system on your injected engine. Your engine should continue to run smoothly under all power settings. Only under emergency conditions should you make massive, abrupt power changes. Smooth throttle control is sign of a professional. Try to plan your landings and take-off procedures so you make gradual power changes. Helps engine life considerably.

OXYGEN

Question: What types of oxygen are legal to use in my airplane?

Strange as it may seem, any kind of oxygen is legal for aircraft use. The reason for this is that there is no FAR yet to specify what kind. The only thing you find is in FAR 91.32 which spells out the conditions under which supplemental oxygen is required; but they omit putting any qualification on the "supplemental oxygen." The principal practical development of supplemental oxygen has taken place in the military, where high altitude sustained flight was of high security value. Out of this environment came the idea that one needed "Aviator's Breathing Oxygen", which was low in water vapor. This latter condition was presumed to prevent frozen water particles from disabling the pressure regulators and other equipment usually placed between the oxygen tank and the pilot. In the days of open cockpits and winter flight conditions, supplementary oxygen equipment was exposed to freezing temperatures. These days, with most of us flying in cabin aircraft, and with space heaters, we seldom have either ourselves or our equipment exposed to freezing temperatures. The water vapor content of the oxygen becomes more or less academic. In the military, and in some air carrier aircraft, depending on the location of the storage tanks, water vapor may conceivably still be a concern.

After a number of telephone calls, I was finally able to talk to the gentleman in the FAA in Washington who is currently working on an FAR governing aviation oxygen usage. To him, I quoted the old idea about water vapor, and I asked whether he had at hand actual environmental test results, where an oxygen tank, regulator, and other equipment had been placed in an altitude chamber at reduced pressure, using oxygen with various water vapor contents. That kind of testing would show what levels of moisture would be allowable. The gentleman advised that they had no such test results and were not anticipating any. Perhaps we will receive yet more regulation based on guesswork.

Usually the second question asked in this area is addressed to how much oxygen is needed. A good rule of thumb is to give yourself one liter of 100% oxygen per minute for each 10,000 feet of altitude ASL. This is what a normal healthy adult requires for full mental function. Most commercial equipment you buy for aircraft usage will furnish several times that amount. We have an on-board permanent system in our bird, with five outlets on the oxygen console in the cabin. One of these outlets is labeled "pilot". This one gives 3.5 liters per minute regardless of altitude. The other four, for passenger use, gives 3.0 liters per minute, regardless of altitude. At considerable expense, one can buy automatic equipment which supplies more oxygen as you ascend and vice versa. In the last very few years there has been available a small, relatively inexpensive individual flow meter with which one can manually ad just flow rate, to achieve the minimum flow rate of one liter per minute. The obvious reason for limiting flow rate is to make your supply last as long as possible, and still not go hypoxic. If you are flying at 15,000 feet, you need only 1.5 liters per minute. At 3.5 liters per minute, your supply will last only 43% as long as it would at 1.5 liters per minute.

One last item and this month's business is completed. Many people ask about smoking in the aircraft when somebody is using oxygen. If you wish to run your own test, try this: with your aircraft sitting on the ground, hook up your oxygen mask, turn it on full force, bring the mask outside the open cabin door and hold a lit cigarette right in the mask. I have seen it done and tried it myself. Nothing happens. In my opinion, it is not unsafe, as far as fire and explosion are concerned, to smoke in the cabin while somebody is on oxygen. For other aspects/on smoking. Just don't do it!

ED: Before not using Aviators Breathing Oxygen check regulations of country of aircraft registration.

PROP STROBE EFFECT ON RPM

I read with interest the letter from a member in the December 1979 issue of the Flyer commenting on the interesting strobe effect one can see when viewing one rotating propeller through another. There was a comment that one could check the relative accuracies of the two planes' tachometers but it would be difficult to say which one was correct.

However, there is a way to check the accuracy of each tach independently without any equipment at all.
Just taxi into the light of a high intensity mercury lamp at practically any airport. These are the kind that throw a lot of light at night and have a some what blue-white color. If you then turn the plane so that the light is shining on the back of the prop and there is darkness in front of the plane, you can get the same stroboscopic effect that was observed. This effect is seen because the light is actually turning on and off at 60 times per second - the 60 cycle line frequency. It is this line frequency which keeps all our clocks running accurately and thus you have a very accurate, free stroboscope. Just run the engine up to a point which is a submultiple of 60 revolutions per second, i.e. 1,200 RPM is 20 revolutions per second, 1,800 RPM is 30 rps, and 2,400 RPM is 40 rps. At each of these speeds the stroboscopic effect of the light will cause the prop to appear to stand still with multiple blades. When the multiple bladed prop is still, compare the tack reading with the number nearest 1,200 RPM, 1,800 RPM or 2,400 RPM and note the difference. If you start at a low speed and stop at each point the prop appears to stand still, you can calibrate the tach at 600, 900 (lots of blades), 1,200, 1,800, and 2,400 and be very sure exactly how far off each of these important settings are. Set the brakes, have a copilot take the readings and keep the area clear. Keep your eyeballs outside while the copilot's are in the cockpit.

APPROACH SPEED PERFORMANCE

The Comanche has a reputation as a difficult airplane to land; a "floater," that doesn't want to quit flying, with a tendency to touchdown nose wheel first. A number of theories have been offered to explain this problem including "expert" opinions that the nose gear strut is too long and the main gear struts are too short. Some folks have even advocated over-servicing the main gear struts, to extend them and ensure the main wheels contact the ground before the nose wheel does.

ED: Over extending struts will not accomplish this!

Having heard and read about Comanche landing quirks, and experiencing a couple of peculiar "arrivals" in my own bird, I've looked into the subject and come up with a few thoughts I think may be of interest to other Comanche flyers. Since I know more about the Comanche 180 than any of the other models, I'll confine my discussion to the 0-360 powered version. However, the principles would seem to apply to any Comanche.

Since I think we can all accept the fact that a good, stable approach is the key to a good landing, let's start by looking at approach speed. My owner's handbook (Piper No. 752 467, revised February 1974) doesn't go into much detail on the subject but does, on page 22, recommend an approach speed of "...about 85 MPH." On page 23, discussing high winds and strong cross winds, the manual states, "...it may be desirable to approach the ground at higher than normal speeds, with partial or no flap." This indicates a speed above 85 MPH is required with less than full flaps and also implies that under some wind conditions a higher than normal approach airspeed should be maintained even with the flaps full down. All this sounds reasonable and seems to have been fairly well accepted by Comanche pilots. When I checked out in mine, the previous owner recommended 80 to 85 on final until landing is assured and most articles about Comanche flying mention an approach speed somewhere between 80 and 90 MPH. Are these really the correct airspeed? Maybe ... maybe not.

It's generally agreed that the proper approach speed for an airplane like the Comanche should be about 130% of the poweroff stall speed for the particular configuration being flown, i.e., flaps up or down. This is normally written as 1.3Vs, (1.3 times Vs, the power-off stall speed) and is designed to provide an adequate airspeed margin above stall speed to ensure good control response on final approach and to compensate for airspeed fluctuations caused by normal wind gusts. To see how close the recommended 85 MPH is to 1.3Vs, all we need to do is find the stall speed and multiply. Looking in the books, we find not one, but two, published stall speeds for the Comanche 180.

The Owner's Handbook shows the Comanche 180 will stall at 61 MPH while the Flight Manual for my airplane says it will stall at 60. Since the Flight Manual should take precedence, we'll use 60 MPH and, multiplying by 1.3, we come up with 78 MPH as a normal approach speed. That could be rounded off to 80, which is in the ball park, but it is a full 7 MPH below the handbook's recommended 85 MPH.

We should also note that the published stall speeds are based on a full gross weight of 2,550 pounds. Since we probably don't make many landings at that weight, and light airplanes will fly slower than heavy ones, let's see what the stall speeds and approach speeds are as the airplane weight decreases. We can do it by using the formula:

Va / Vb = square root of GWa / GWb
Where Va and GWa refer to the first speed and gross weight and Vb and GWb refer to the second speed and gross weight. Using 60 and 2,550 for Va and GWa respectively, we'll plug in 2,000 pounds for GWb (typical for two people, no baggage and about half-fuel) and solve for Vb. If you try this, and don't miskey your calculator, you should come up with a stall speed of about 53 MPH and an approach speed (1.3Vs) of 69.1; over 15 MPH slower than the book's recommended 85 MPH.

Let's consider another, even lighter airplane. One pilot (a slender one), with no baggage and about one hour of fuel aboard could give us a gross weight of about 1,690 pounds. Using this figure for GWb, with the same Va and GWa, we find the stall speed is now down to about 48.8 and approach speed has decreased to 63.5; more than 20 MPH below the recommended 85 MPH approach speed. Flying 85 MPH, at this weight, would leave the pilot with over 36 MPH to lose during the flare to touchdown at stall speed. Is it any wonder that Comanches sometimes seem reluctant to quit flying? Or that it's difficult to keep the nose wheel off the runway? If you try lifting the nose during the flare with this much extra airspeed, the airplane will probably climb instead of landing.

But what about the 85 MPH approach speed? Is it a meaningless number? Not really. In fact, it seems to be designed to keep you out of serious trouble under the worst possible conditions. For example, extra airspeed during the flare is usually just annoying, but running out of airspeed on final approach can be disastrous. Since the Comanche can be landed with the flaps full up, and the Flight Manual says Vs at full gross weight in this configuration is 67 MPH, the approach speed for a no-flap landing at full gross weight is 87.1 MPH, or "about 85 MPH." In other words, 85 is probably the highest approach speed you'll ever need in the Comanche 180. If you simply use it all the time, you should never wind up running out of airspeed and ideas on short final. On the other hand, if you're interested in more precision piloting, and you'd like to make the mid-field taxiway turnoff more often than you do now, take a look at figure one. It shows the approach and stall speeds, for a Comanche 180, with full flaps, at all gross weights from 1,500 to 2,550 pounds. To use it, you'll need to keep track of your airplane's actual weight and you might want to break the speeds down into 5 MPH increments to simplify things. For example, use 80 MPH for approach speed until your airplane weight drops below 2,350 pounds, then use 75 until the weight drops below 2,050. You can then use 70 MPH down to 1,750 pounds and 65 below that, as shown in figure two. Remember, these speeds are for full flaps; anything less and approach speed must be increased.

Additionally, since a little extra airspeed is usually a good idea in gusty winds, you should consider increasing approach speed when landing under these conditions. Adding about 50% of the difference between the prevailing wind and the peak reported gust is a good rule of thumb. For example, if the winds are reported as 10 knots gusting to 20, the difference is 10 knots and 50%, or half, of that is 5 knots which should be added to your approach speed. (Winds are almost always reported in knots these days so, if you're flying miles per hour, you'll have to convert to come up with a valid correction factor.)

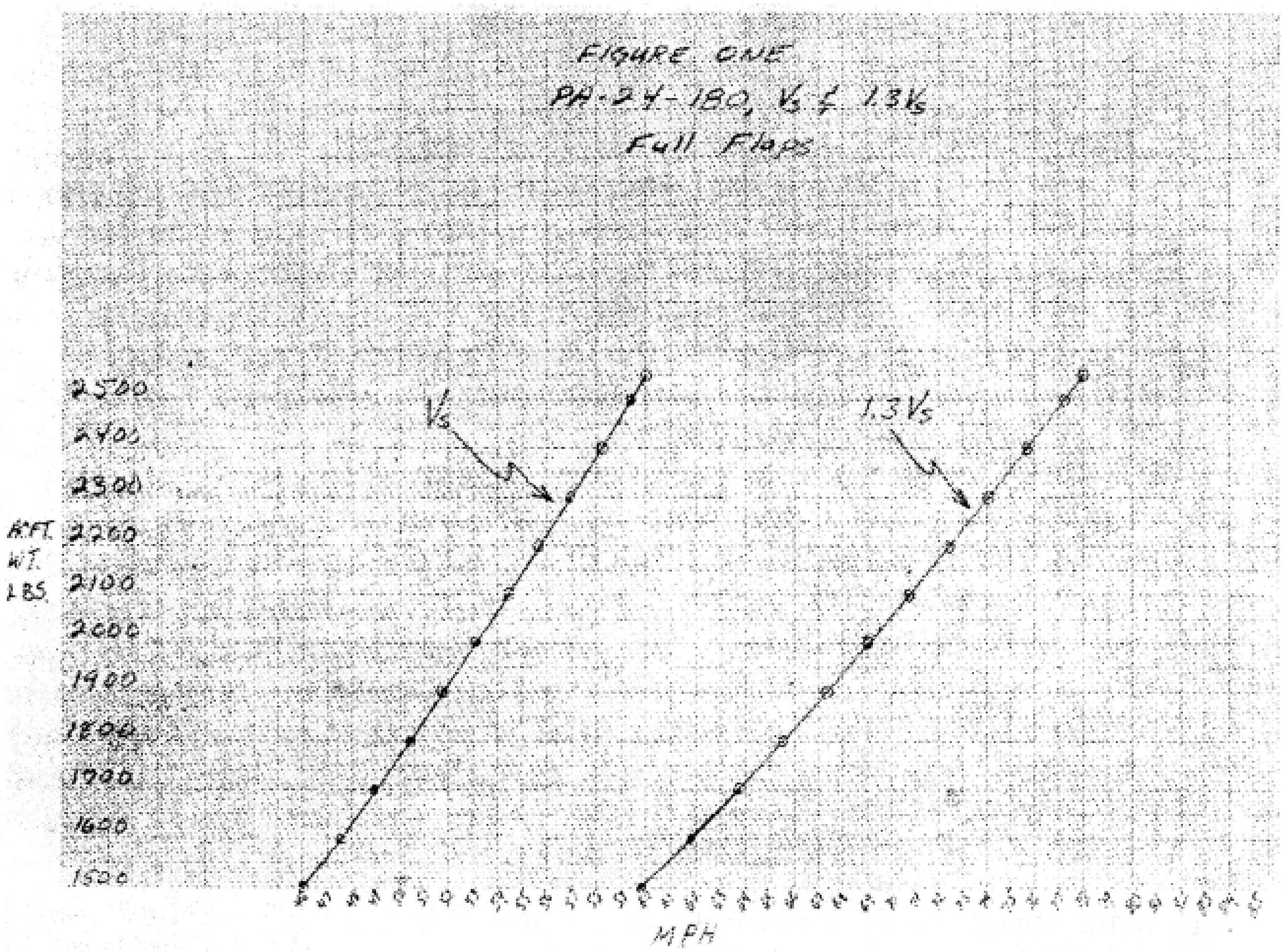


FIGURE TWO
PA-24-180, Full Flaps

ACFT WEIGHT (Pounds)	APPROACH SPEED (MPH)
Above 2,350	80
2,050 to 2,350	75
1,750 to 2,050	70
Below 1,750	65

While reduced approach speeds may not guarantee perfect landings every time, they should reduce the Comanche's tendency to float and make it a little easier to keep the nose wheel off the ground until the main gear wheels are firmly down. You should insure that your airspeed indicator is accurate at high altitude before trying these approach speeds.

APPROACH SPEED PERFORMANCE

You may find the attached approach speeds chart for the 180 Comanche interesting. Our airplane is very speed sensitive in the landing realm and practically no information is published. My manual mentions 85 MPH on final, but since the manual covers both the 180 and 250, that speed really is for the 250. 85 MPH comes out right at 130% of stall for the 250 at gross, whereas the 180 comes in at 78 MPH for 130%. The difference in full flap and no flap air speeds is interesting. The speed differential at varying weights is interesting too. I believe I would suggest the 1.3 speeds for stable air condition and proficient Comanche pilots. Otherwise the 1.4 speed might be better.

Weight	27^{o} Flaps	No Flaps (Note: Speed/MPH)	
		1.3 / 1.4	1.3 / 1.4
	2550	78 / 84	87 / 94
3 pers, full tanks	2375	75 / 81	84 / 91
3 pers, 1/2 tanks	2200	73 / 78	81 / 88
2 pers, full tanks	2200	73 / 78	81 / 88
1 pers, full tanks	2040	70 / 75	80 / 84
2 pers, 1/2 tanks	2040	70 / 75	80 / 84
1 pers, 1/2 tanks	1840	66 / 71	74 / 80

APPROACH SPEEDS

While reading "Tips", I ran across the article by Ed Ross on approach speeds. Ed had a formula for calculating approach speeds for different weights. With some minor editing on my part, the formula is essentially:

Vs / V1 = square root of GW / GW1
Or
V1 = Vs / square root of GW / GW1

Where Vs is gross weight stall speed, GW refers to gross weight, and respectively, V1 and GW1 refer to a calculated stall speed at a specified aircraft weight. The second formula is solved for any secondary stall speed (Vi) by entering known values for Vs, GW, and any intermediate weight for GW1. You can also substitute Vso for Vs and calculate Vso for all appropriate weights.

This is tough to figure on my flight computer (considering it doesn't do square roots), so I completed the attached approach speed charts using 1.3 times Vs and Vso as standard approach speed and 1.4 times for windy/gusty conditions (remembering to allow for gusts). You'll notice that the charts cover both the 250 and 180, in MPH. I figured that I might as well cover everybody. I know that there are other stall speeds quoted in some books, so I would be happy to prepare similar charts for anyone interested.

When I completed the chart for my 250, the speeds seemed too low (especially compared to another approach speed chart I saw in "Tips"), so I completed a similar chart for the PA-28-181 Archer. The Stall Speed chart in my Archer manual confirmed that the speeds calculated by the formula are correct. I don't know whether this formula is accurate for laminar flow wings, so users can decide if they want to add an additional safety factor.

You also might be interested in knowing that a rule of thumb for best endurance speed (from Kershner's Advanced Pilot Flight Manual) is to use 1.3 times stall speed for single engine retractable w/flaps up. This figure is CAS and the lower the altitude the better the endurance. So, the 1.3*Vs column provides best endurance speed at various weights too! Hope this is helpful.

PA24 Approach Speed MPH

<u>PA24-180</u>

	Approach Speed MPH (0 Flaps)			Landing Speed (Full Flaps)		
Acft Weight	Vs	1.3 Vs	1.4 Vs	Vso	1.3 Vso	1.4 Vso
1450	50	65	70	46	60	64
1500	51	66	71	47	61	65
1550	51	67	72	48	62	67
1600	52	68	73	48	63	68
1650	53	69	74	49	64	69
1700	54	70	75	50	65	70
1750	55	71	77	51	66	71
1800	55	72	78	51	67	72
1850	56	73	79	52	68	73
1900	57	74	80	53	68	74
1950	58	75	81	53	69	75
2000	58	76	82	54	70	76
2050	59	77	83	55	71	77
2100	60	78	84	55	72	77
2150	61	79	85	56	73	78
2200	61	80	86	57	74	79
2250	62	81	87	57	74	80
2300	63	81	88	58	75	81
2350	63	82	89	59	76	82
2400	64	83	90	59	77	83
2450	65	84	91	60	78	84

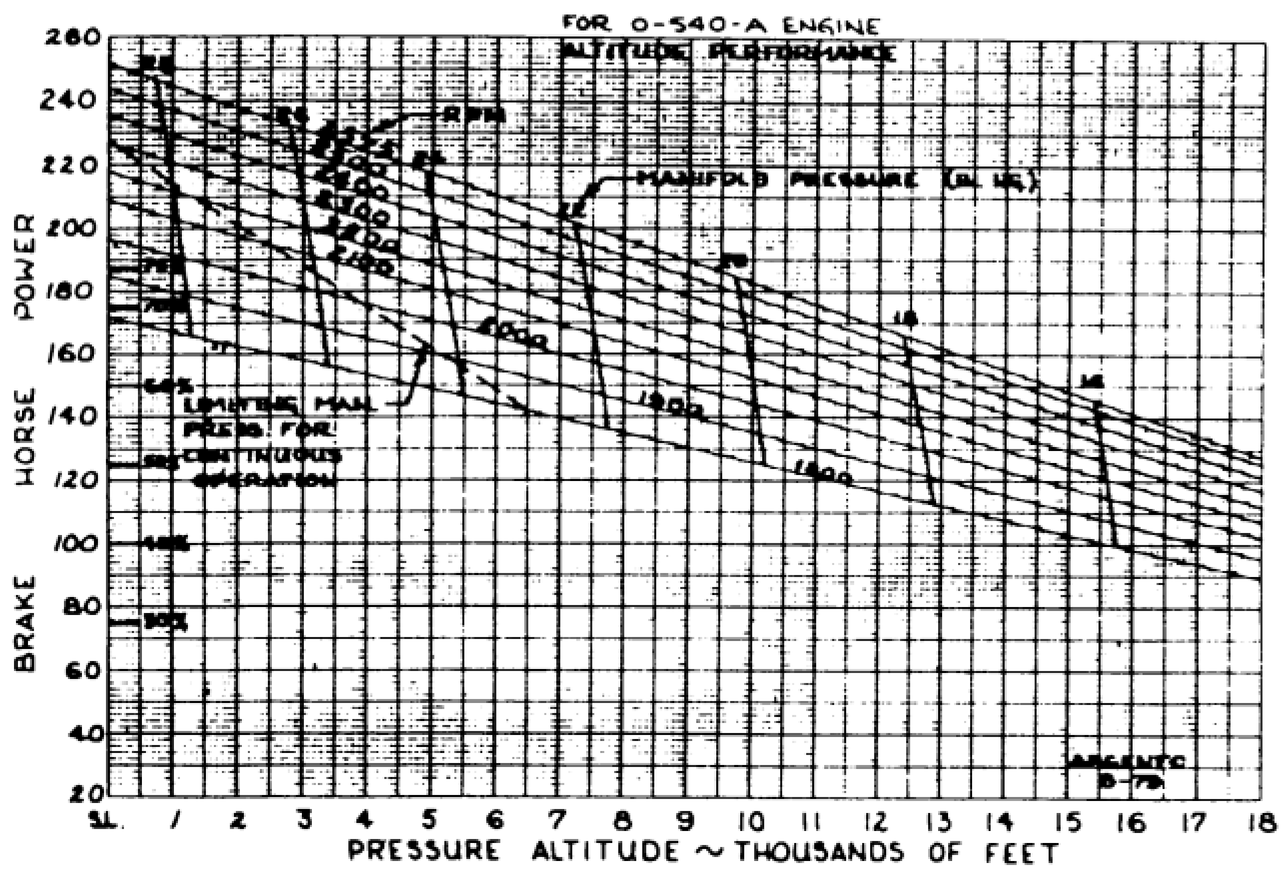
2500	65	85	91	60	79	85
2550	66	86	92	61	79	85

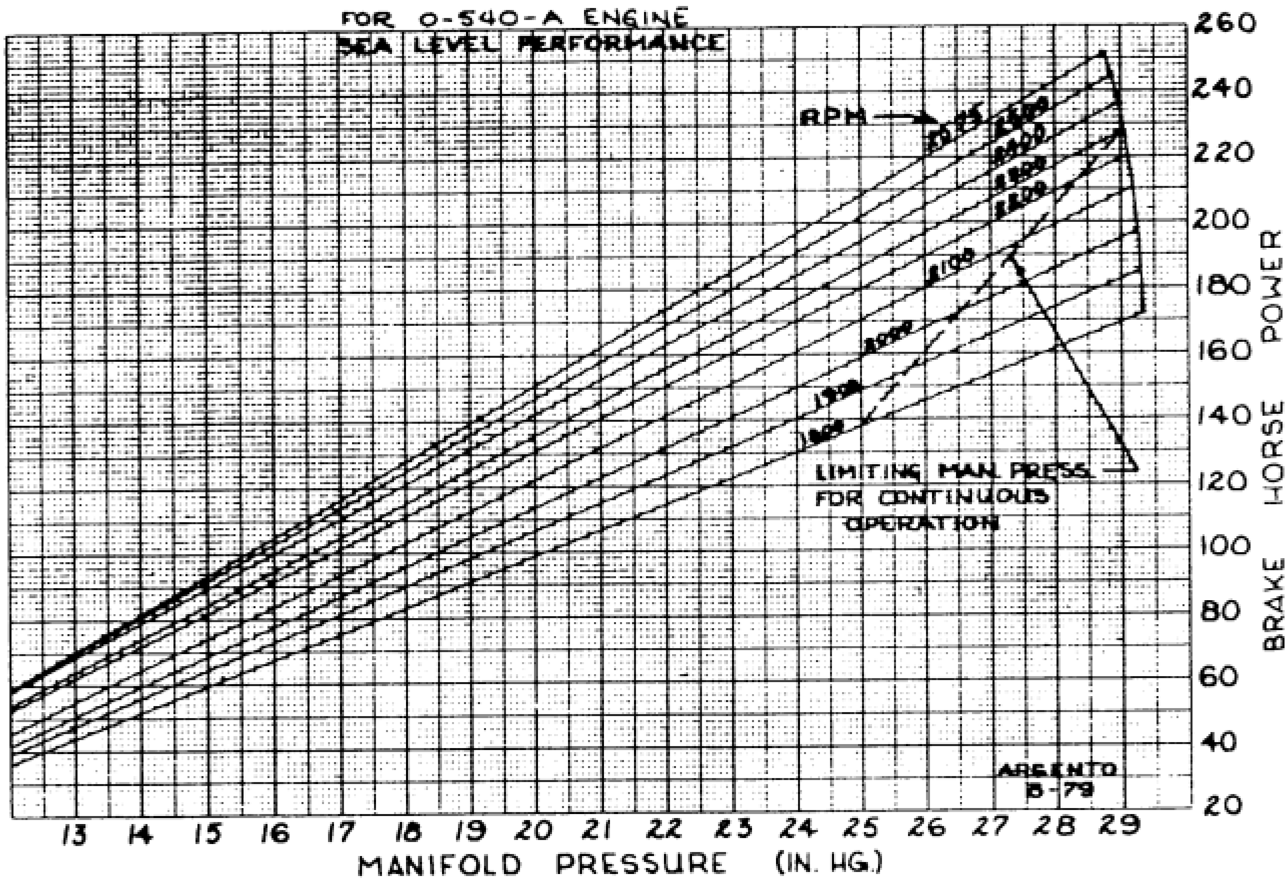
PA24-250

	Approach Speed MPH (0 Flaps)			Landing Speed (Full Flaps)		
Acft Weight	Vs	1.3 Vs	1.4 Vs	Vso	1.3 Vso	1.4 Vso
1700	53	69	74	49	64	69
1750	54	70	75	50	65	70
1800	54	71	76	50	66	71
1850	55	72	77	51	66	72
1900	56	73	78	52	67	73
1950	57	74	79	52	68	73
2000	57	74	80	53	69	74
2050	58	75	81	54	70	75
2100	59	76	82	54	71	76
2150	59	77	83	55	72	77
2200	60	78	84	56	72	78
2250	61	79	85	56	73	79
2300	61	80	86	57	74	80
2350	62	81	87	58	75	81
2400	63	82	88	58	76	82
2450	63	82	89	59	76	82
2500	64	83	90	59	77	83
2550	65	84	91	60	78	84
2600	65	85	91	61	79	85
2650	66	86	92	61	80	86
2700	67	87	93	62	80	86
2750	67	87	94	62	81	87
2800	68	88	95	63	82	88
2850	68	89	96	63	82	89
2900	69	90	97	64	83	90

CHARTS FOR 0-540-A ENGINE

1. On sea level performance figure, locate the point of intersection of the selected manifold pressure and RPM. From this point, move horizontally to the right and find the related brake horse power for this manifold pressure, RPM combination. (Point No. 1)
2. On altitude performance figure, locate the value of brake horse power determined in Part 1, on the sea level (SL) pressure altitude line. (Point No. 2)
3. On altitude performance figure, locate intersection of selected manifold pressure and RPM. (Point No. 3) On this figure, connect Point No. 2 with Point No. 3 by a straight line.
4. For the selected pressure altitude, locate the intersection of this altitude with the straight line drawn in Step 3. (Point No. 4)
5. From Point No. 4, move horizontally to the left to find the horsepower being developed at standard conditions for the selected manifold pressure, RPM, and altitude. (Point No. 5)
6. Correct this horsepower for actual temperature at altitude:
   Actual HP = HP at Point No. 5 x the square root of 460 + Ts divided by 460 + T
   Ts = Standard Temp (Zero F) at Chosen Altitude
   T = Actual Temp (Zero F) at Chosen Altitude





FUEL SELECTOR ON, NO FUEL

Our "baby" is a 1960 '180 that I have owned for 11 years now. The airplane has given us 2,800 almost trouble free hours of service. I had, in all this time, one experience worth sharing with the other members. Soon after I bought the bird in 1969 had a power interruption and forced landing due to fuel starvation occasioned by operating with both fuel tank selectors on (have Brittain tip tanks). Upon investigation found that by so positioning the valves, one tank will be exhausted first (the one from which fuel flows with least resistance) and when it runs dry, the fuel pumps (both electric and engine driven) will then draw air. The remedy using the Brittain fuel valve is to operate on one tank at a time only, but no placard denoting this is provided or specified.

I solved the problem by going to a '260 tank selector valve which can be positioned only on one tank at a time.

TAKE-OFF PERFORMANCE

My 1962 PA-24-250 (with I0-540) has a label by the flap indicator that says, "Take-off Flaps 15". This is an "add on sticker" that was on the panel when I bought it some years ago. When I checked out in 23P, the check pilot had many, many hours in Comanches and recommended the 15 position. I do a lot of short field work (1,000' - 1,500') with 23P and find that she fairly leaps off the ground this way.

LANDING WITH FULL NOSE UP TRIM

Someone made the comment that they landed their 180 with full nose up trim and that a lot of other pet tricks were dangerous. I want to point out that this technique with some airplanes, and the 400 is one of them, will put you in the early stages of a small loop when full power is applied for go-around. Imagine this situation in an actual instrument conditions go around from a missed approach. Instant vertigo followed by a stall. You can get away with it in a 180 but I strongly suggest you practice it (cautiously) in any other type airplane. It must be remembered that the 180 is the best landing and flying of all the Comanches as it was designed for that engine. The others have higher elevator loads due to heavier engines, especially the 400. As a general practice, I suggest most airplanes be landed with the trim required for a stabilized final approach speed of 130 percent of stall in the landing configuration.

ECONOMY FLIGHT TIPS

The May issue of the Flyer was indeed the best ever, with several excellent articles and helpful letters. I applaud, particularly, the articles by Gordon Graham on fuel economy and by Jim Scott on potential performance mods. A Mooney style clean up of a less ambitious measure would certainly tweak the performance and economy of all models, and I know a lot of proud Comanche owners would gladly invest in the improvements. I agree with Jim that the nose wheel bay doors, flap and aileron gap seals and main gear well covers would yield the most knots for the fewest bucks.

Gordon's article set me to thinking about a couple of economy tips I don't believe I can endorse. First of all, he is absolutely right in stating that the farther aft the C.G. moves within the envelope (actually, the closer the C.G. to the center of lift, envelope or not), the less induced drag is produced by the wing and stabilator. However, weight always increases induced drag, regardless of C.G., and this is not a linear equation. I don't believe Gordon meant to say that increasing the weight would increase speed. As weight increases, total lift must also increase. For a given airspeed, this implies a higher angle of attack (AOA). As AOA increases to produce the required extra lift, drag also in creases but at a much higher rate. The airspeed will then decrease to an equilibrium for a given power setting, at which the increase in induced drag equals the reduction in parasite drag from the reduced airspeed.

Typically for a Comanche 180, the weight penalty manifests about a seven knot difference in cruise speed between a lightly loaded aircraft and one at gross weight. Location of the C.G. can make another few knots difference at the extremes of the envelope, but I haven't been able to measure the effect at a constant weight.

While loading to the legal rearward C.G. limit does reduce induced drag, this benefit may be more than offset by less static longitudinal stability, the ability to hold its trimmed airspeed. Other aircraft - notably the Bonanza (yech!) and the Apache (double yech!!) - become negatively stable (pitch divergent) long before their C.G. reaches its aft limit. Most aircraft are affected by this phenomenon to some degree. I haven't seen any specific data about the Comanche, so I throw this out only as a precaution: Every loading envelope is somewhat elastic at the top, but you should consider the sides of that envelope to be absolutely rigid.

Another economy tip I'd like to pass on is probably intuitively obvious to a lot of Comanche owners already. As an Air Force F- 15 pilot, I found that best range airspeed is not necessarily optimum cruise. Our performance charts verify that, as a rule of thumb, best range is obtained by increasing air speed by one half the headwind component up to Mach .95 or by decreasing airspeed by one half the tailwind component (but not below 270 KIAS) from optimum cruise. The same is true in the Comanche. Best economy (miles per gallon) in the face of a 40 knot headwind occurs around 85 percent power. I use 75 percent against any headwind in excess of ten knots, 60 percent with a tail wind of more than ten knots. Of course, your most efficient speed and power setting can be computed more precisely, but those are easy for my students to remember.

Gordon's other comments about cost per mile vs. miles per gallon were right on the mark. The reduction of RPM's at a given manifold pressure does indeed extend range. As Gordon pointed out, the technique was used extensively during World War II to extend the range and combat capability of combat aircraft and generally applied to large radial engines with relatively short TBO's anyway. My personal feeling is that with avgas prices as they are, the fuel saving will more than compensate for the lower true air speed, but that is a trade off each owner should consider.

GROSS WEIGHT

Q. While browsing through some back issues of the Comanche Flyer, I came across a statement you made concerning gross weight. The 1958 Comanche 250 had a gross weight of 2,900 lbs. We recently acquired 6400P, a 1960 Comanche 250. The owner's manual and weight balance papers both show a gross weight of 2,800 lbs. Were the gross weights changed sometime after the original papers and manual were issued? How could I confirm or check the 2,900 lb. figure. If the weights were changed, what process is required to use the new weights?

A. Yes, the gross weights were changed. This was done at the time 4 fuel cells were added. There is no conversion to accommodate this and due to significant structural changes is not practical. These are the weights by serial number: 2,800 lbs. gross, Serial #1, 103-2289 inclusive, Except 2003; 2,900 lbs. gross, Serial #2003, 2299 and up.

EMPTY TIP TANKS ARE DANGEROUS

A problem that caused much heart flutter was a partial engine failure during climb that occurred about 6,000 feet. This was traced to air being drawn into the fuel system across the selector valve when the tip tanks were empty. Remedy, keep some fuel in the tip tanks.

ECONOMY FLIGHT TIPS

On the Comanche, the wheel is cocked when retracted with the forward portion retracted inside the wing and the aft portion hanging below. To be effective for us we need an after body fairing behind the wheel and a single sheet metal door attached to the gear yokes that covers approximately 2/3 of the wheel well when retracted. This is in addition and separate to the stock door that covers the strut well when retracted. Mooney has the same geometry and this was their simple solution worth 6 MPH to them. I do not endorse full gear doors, ala Bonanza, etc., and agree the complexity and expense is not worth it. Roy Lopresti's "speed spats" are the answer.

JET FUEL

Frequency of improper fueling will diminish if owners, pilots and personnel servicing aircraft maintain vigilance. Should the occasion arise where the tanks in an aircraft are accidentally filled with jet fuel, the following procedures should be followed:

1. If engines are not operated after refueling with jet fuel, drain the fuel tanks, lines and system completely. Refill the tanks with proper grade of aviation gas and run the engine or engines for approximately five minutes.
2. If the engines were operated subsequent to refueling with jet fuel, investigate abnormal operating conditions such as those related to the fuel mixture and cylinder operating temperature. In addition the following should be done:
   a) Perform compression test of all cylinders;
   b) Completely borescope and inspect the interiors of the cylinders; giving special attention to the combustion chamber and piston dome;
   c) Drain the engine oil and check the oil screen or filters. Further investigate and correct any unsatisfactory condition found;
   d) Completely drain the fuel tanks and entire fuel system including the engine, fuel servo or carburetor;
   e) Flush the fuel system and carburetor or fuel servo with gasoline and check for leaks;
   f) Fill the fuel tanks with proper grade of aviation gas;
   g) If the engine inspection was satisfactory, complete an engine run up check.

Anytime your aircraft is filled at an airport where jet fuel is present, it would be a good idea to make sure you have aviation gas and not jet fuel. All fuel tanks should be marked with the minimum fuel requirement by grade.

TAIL SHAKE

Tail shake at high speed but below "Red Line". Check for looseness between elevator trim tabs and actuator rod. Bushings may be worn or bolt "sloppy". Clevis or "precision" bolt will help. Tighten up snug but leave loose enough for motion between tab arms and actuator rod.

ED: Also check compliance with AD74-13-01.

JAMMED GEAR RETRACTION

On a beautiful Saturday afternoon in late March, while departing Pine Mountain, GA Airport; following an enjoyable tour of (Callaway Gardens my Comanche and I had a rather unusual and frightening experience.

While doing the pre-departure routine at the end of the runway I had seen an "Ag Cat" over the airport, but could not find it again. I even delayed my departure a bit to give him time to get on the ground. Still no "Ag Cat".

Announcing my departure on Unicom, we rolled. Wife, Barbara in the right seat; and daughter, Ellen (16), already half asleep, in the back. Still no sign of the "Ag Cat". I put the Gear Switch to UP, and looked for that guy. He's got to be somewhere out there.

Suddenly, Barbara lets out a piercing scream! Fully expecting to see a big Radial devouring the right wing, I take a quick look - nothing! More screams from the right seat. Now I look at her. She is obviously in real pain. My first thoughts were that an insect had bitten her, or she had an ear problem. We are not much more than a hundred feet off the ground. It can't be her ears. Finally I ask her what is wrong? She points to the floor - her left foot is caught beneath the Landing Gear Emergency Extension Lever!

Placing the Gear Switch to DOWN brings no relief. The motor has been stalled long enough for the circuit breaker to open. Trying to reset the circuit breaker produces no results. Put the Gear Switch to off, and try to help her move her foot from beneath the lever. Forget it - she's really trapped and in intense pain. I try the circuit breaker again, and at last it seems to reset. This time when the Gear Switch is placed in the DOWN position the lever moves, and she is free; but not free from pain.

Now I want to land and check the damage to her foot, but she wants to go home since it is only 50 minutes away. Upon arriving back in Gainesville it is obvious that the foot is swelling noticeably. A trip to the Emergency Room 3 for X-rays shows no broken bones, but the pain and swelling persisted well in to the next day.

All of the action took less than a minute from start to finish, but during that time the airplane was being flown more by instinct than anything else. I am thankful for the 28 years of flying experience that built that instinct and for the good weather. There must be a lesson in this and I suppose it is very obvious - always make certain that the area where that lever goes is free of anything that might interfere with its operation. I don't think I will ever forget to admonish passengers about the necessity to keep their feet away from that area. There will of course be one exception to that rule since I don't think Barbara will ever need to be told about the dangers again.

OIL TEMPERATURE GAUGE HIGH READING

In regards, the problem with the oil temperature gauge, we had the same trouble with our PA-39. About six months after we bought it we were coming back from the Midwest and the oil temperature on the right engine went up to about 240 degrees. We throttled back and watched the oil pressure and cylinder head temperature and they seemed to be normal, so we limped home. I switched oil temperature probes but no luck. I couldn't get to the temperature gauge to switch instruments. I tried to buy a new gauge but the shop said I had to buy the whole set (six) for $300 so that was out. We put in a new vernatherm and that didn't help either. I called the Lycoming representative and he said don't fly it so I called Maurice Taylor and told him the story and he couldn't believe it was really overheating. It wasn't.

While sitting around the bar at a fly-in at Ramona, CA talking to Harold Mauser from Phoenix I finally got some insight into the problem. Harold was Chief of Maintenance for Hughes Air - West. He said it was probably caused by induction from the alternator. He advised me to turn off both alternators and pull the circuit breaker on the temperature gauge for a few seconds then turn the breaker on and run on the battery. By George, it worked! The oil temperature stayed right at 210 degrees. As soon as I turned on the alternator the temperature would go right up to 240 - 250 degrees. I tried it two or three times and it always worked. While riding to ABQ one night with the late Dale Alexander in his PA-30 (he died of a heart attack last October) the oil temperature was reading 240 degrees. When I asked about it he told me not to worry it was OK So I had him turn off both generators and it came right down to 210 degrees.

FUEL SELECTOR VALVE OFF FOR BELLY LANDING

Many years ago the Gr - jackscrew - sleeve failed jamming the emergency-extension-lever-release in the lightening hole, which made extension impossible by any means. A landing was made sans wheels with power down to the flare point. "Slide out" was straight thanks to the Comanche's very effective rudder. Despite two very experienced aviators, we forgot a very important item; the fuel selector. The Comanche "rides" on its belly from a point about 1' off of the firewall to the point where the belly angles up sharply to the tail cone. Damage is minimal if the wings are kept level the A/C kept straight with rudder and excessive elevator is not used, being limited to the area bounded by the wing leading and trailing edges. (And in our case the old ADF loop dome housing.) Unfortunately in this area is located the fuel selector valve and drain bowl. With the fuel left on as the bowl is ground off, fuel flows to hot metal and fire results. Our 1 # dry chemical bottle fortunately put it out. So it ever faced with the situation do turn off the fuel at the selector.

FLAP MAINTENANCE

The problem I would like to share with the members concerns flap operation. This problem has been mentioned before, but a recent letter from Robertson Aircraft prompts me to call this to our member's attention. It seems there is no positive flap retraction system on the Comanche Aircraft except the 400 models.

One day after liftoff with our Comanche, a 1959 180 HP, we encountered an extreme left roll tendency. This rolling movement could barely be overcome with full opposite aileron. What had happened was on preflight check, I had operated and retracted the flaps, but one flap remained fully extended. Even more embarrassing to me was not noticing this condition prior to takeoff. Examination proved my mechanic had never lubricated any of the flap mechanism during prior inspections. This asymmetric flap deflection condition could, I feel, lead to a complete loss of control at a very low altitude. I would urge all members to be alert for this hazard, have your flap mechanism checked and lubricated, and DO LOOK AT BOTH flaps during and after preflight operation.

WEST BEND TIMER

Just a short note about a countdown timer I found the other day (made by Westbend). There may be other ICS members looking for an inexpensive tank or approach timer.

It has got a large digital display and is easy to set. Mine clipped right onto the top of the instrument panel overlay and stayed in place during a 5 hour trip yesterday. The case is about 2 inches square.

It will countdown from 99 minutes and 99 seconds or anything in between. For example to set 3 minutes, 21 seconds, just "3,2,1," and when you reach the approach fix press "start". At "0", the timer will begin to beep.

I was concerned that it might not be loud enough in the Comanche, but as a tank timer it was just loud enough to get my attention at cruise with vents open, radios on and door seal leaking, although it won't blast you out of the cockpit and hard of hearing may not hear it at first. It beeps for one minute. As an approach timer, it is very audible at reduced power settings and speed.

There is no internal lighting, but ICS members making instrument approaches at night would probably be well advised to spend more for a better, permanently installed unit.

COLD WEATHER OPERATION

For cold weather starting, assuming the other cold weather recommendations of the previous issues are followed, as appropriate:

1. For carburated engines, fuel boost pump ON (to engine fuel pressure); prime 3-5 times by slowly pulling the primer knob out fully (to fill the primer reservoir) then pushing it in smartly to spray the raw fuel into the intake manifold ports (remember, the 1 st push may only be moving air in the primer lines); then, with master switch ON and the ignition switch in the position necessary to activate the magnetos that are impulse coupling equipped (or as recommended for other magneto types), engage the starter. Upon start, reduce or advance the throttle as necessary to keep the engine running at a fast idle. Once running smoothly, set the throttle for 1,000 - 1,200 RPM for warm-up. Starting should be with the mixture set full rich but then leaned for taxi (to preclude plug fouling) and then reset appropriately for run-up and take-off. If while attempting start, the engine fires but does not continue to run, re-prime and attempt again. If flooded (unlikely when cold), open throttle and engage starter. Engine will fire when fuel / air ratio becomes proper. If attempting a cold weather starter without preheat, the plugs may frost over and refuse to fire. Then if re-attempts prove unsuccessful, pre-heat may be the only remedy (or remove the plugs and defrost them).
2. For injected engines, the cold starting sequence is essentially the same as above. Typically, to prime, advance throttle about half way; advance mixture to full rich until fuel flow is indicated; reduce mixture to idle-cutoff and engage starter. Upon start, advance mixture toward full rich and reduce throttle to fast idle. Repeat if required for re-start. Warm up as above.3) For both engine types, ensure that oil pressure is indicated within 30 seconds after start, or shut down and determine the malfunction.
3. During all phases of cold weather flight - take-off, climb, cruise, descent and approach - use power settings appropriate to maintain proper operating temperatures. Always use full power - smoothly applied - for take off and initial climb. For other flight conditions, operating temperatures may be kept up by using high MP and lower RPM settings (but stay within the factory power chart ranges).
4. Never reduce power suddenly (at any time) or make rapid descents in cold weather. Use a low cruise RPM with 15 - 18 inches MP to maintain temperatures and slow fly or drop gear and flaps if necessary. Use carburetor / induction heat as necessary and never close the throttle fully on approach to landing, especially if a go-around may become necessary. In summary, cold weather starting and operation requires special considerations and effort. But in short, this simply means to maintain the aircraft properly, follow the manufacturer's recommendations, pre-heat when dictated, maintain operating temperatures and avoid thermal shock. Don't baby the engine, but run it as it's designed to be run. It's a Lycoming!

And be careful out there!

RAPID DESCENT

A member has had a top overhaul on the 0-540-AIA engine in his 250 Comanche. He found that all six cylinders had cracks in the exhaust passage area. Although cracks in this area are not too uncommon, it is my understanding that the later cylinders No. LW12424 (plain barrel and No. LW12425 (nitrated barrel) have a revised head which may help to combat this condition. Lycoming does not have chrome barrels. As I see it, the cause of this is too rapid a cool down. If you are at 7,000' AGL and pull the throttle all the way back, or nearly so, the cylinder heads cool so quickly that this causes cracked cylinder heads. If you have to let down fast, slow down enough to drop flaps and gear. Then use as much power as you can to keep the cylinder head temperatures up. You can keep the mixture lean to generate more heat. Try to plan your descents to use some power all the way to the ground; this is most important during cold weather.

FLIGHT LOG FORM

The FAA form 7233-1 combination flight plan and flight log has always frustrated me. The flight plan side is OK. If that's what they want for a clearance, then OK. I'll give it to them. The flight log side however just isn't appropriate for Comanche drivers. First of all, with our long range (even with a 180) you need more than six fixes. And there's too much garbage on the form used primarily for navigation. The winds and weather information can be scribbled in the "route of flight" section of the flight plan.

Anyway, I have redesigned the flight log with information that I feel is needed to conduct a safe flight, especially one of longer range. Main additions are elaboration on times, speeds, fuel used, and reporting frequencies.

DEP.	ID.	TO	MILES	ETE	ETA	EGS	FUEL	RPT
VIA	FQ	FR	TOTAL	TOTAL	ATA	AGS	USED	FREQ

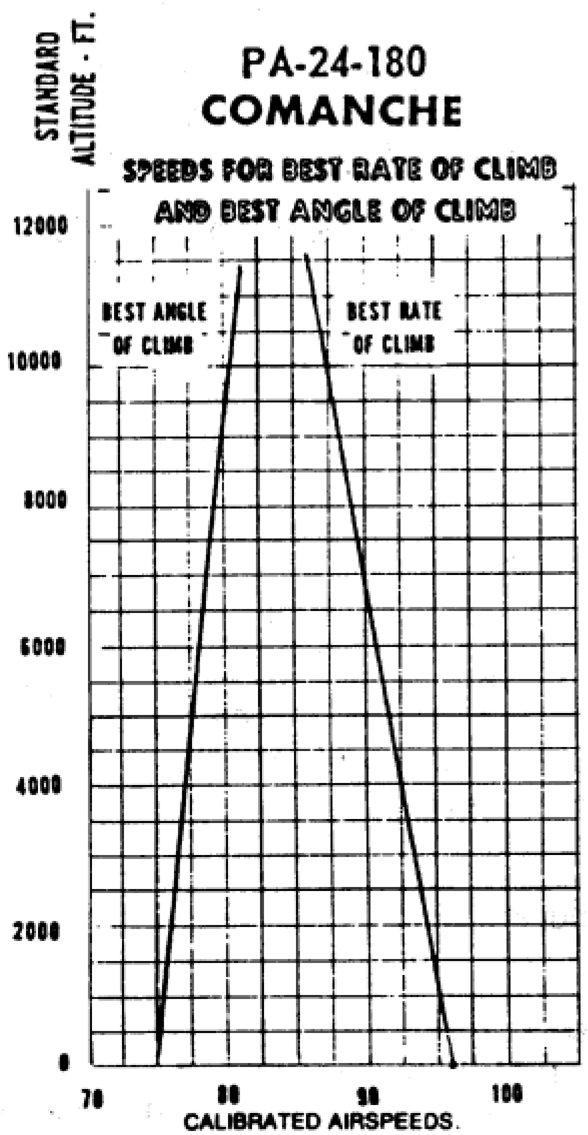
DEPART	ARRIVE	T:O.	LND.	DATE

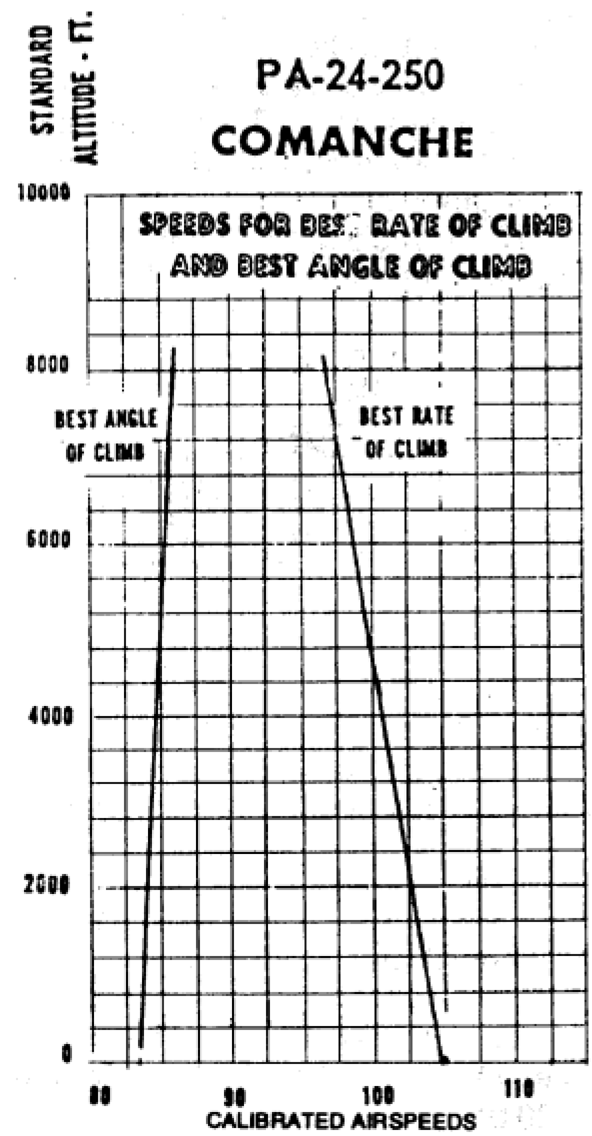
DEPART		ARRIVE	
ATIS		ATIS	
APC		APC	
CT		CT	
CD		GC	
GC		UCOM	

BEST ANGLE OF CLIMB PERFORMANCE

A number of members have asked about Vx or best angle of climb. This is the speed that gives the greatest height for a given distance of forward travel. Handbooks for the 260 and 400 models provide the data in graphs. We have prepared similar graphs for the 180 and 250, based on Piper supplied test data. Please note that the PA24-250 data from Piper was prepared on the 2,800 pound gross weight model. At sea level on an standard day, the Vx is approximately 84 MPH at 2,800 lbs., as depicted on the graph, and for 2,900 lbs. gross weight, Vx is approximately 85 MPH.

I hope that our members flying singles have the good judgement to avoid getting themselves into a position where they need to use the best angle of climb. As for our twin members, the Vx speed is 90 MPH at sea level on a standard day.





FUEL CONSUMPTION

It is easy to see why some pilots believe that "square power" with a constant speed propeller produces the same BHP and fuel consumption at all altitudes. If the MAP gauge measures the pressure of the incoming fuel charge, and this is held constant at higher altitudes, and the engine burns fuel in cruise at a fixed ratio of air and fuel, why isn't the horsepower the same at all altitudes? And the consumption? Have we not put the same "charge" of fuel and air in the engine? The reasoning appears logical, but the problem is that we have not considered all the factors. To be specific, the fuel-air charge is not the same at all altitudes because we have omitted the effect of changing back pressure on the exhaust.

As the airplane climbs to 10,000 ft. on a standard day, the pressure at the exhaust drops from 29.92" Hg. to 20.57" Hg., or 31%. This is a significant reduction. Since the engine is an air pump, this drop in back pressure improves the scavenging of exhaust gases in the cylinder at high altitude (the exhaust gases are "pushed out" by the exhaust stroke and lesser back pressure makes the job easier).

Scavenging of exhaust gases is never 100% complete. The left over gases occupy space in the cylinder and offer resistance to the incoming fuel-air charge. This "dead air" will not support combustion due to lack of oxygen. The total combustion mix at the moment of ignition is there, composed of two parts, a certain amount of residual gas, plus a fresh charge of fuel and air which we intend to hold constant. In order to pump in the correct fresh air charge, we need less manifold pressure at 10,000 ft. than we do at sea level because we have less residual gases (and resistance) at high altitude. If we maintain a constant MAP on climb, the engine will automatically pump more fresh fuel and air to make up for the decrease in the amount of residual gas. Manifold pressure must be reduced with altitude to correct for the,effect of exhaust back pressure on the quality of the total fuel mix within the cylinder.

This effect has given rise to a "rule of thumb" for setting power, which is fairly accurate on any piston engine in standard air. If you know the MAP and RPM for a given horsepower at sea level, the manifold pressure will drop 1/4" Hg. for every 1,000 ft. of altitude change at the same RPM and horsepower. Piper's tabulation in the Comanche 250 handbook follows this MAP progression fairly closely. The rule is used primarily for holding constant BOP on climb.

For a given engine, "x" amount of brake horsepower at a certain RPM requires "y" weight of fuel, because we are simply converting energy, and the energy of gasoline is fixed. BOP directly controls fuel consumption. There are no engineering corrections for change in fuel consumption with altitude at a constant BOP. A piston engine burns the same amount of fuel at 8,000 ft. as it does at sea level to produce the same brake horsepower at the same RPM. Fuel consumption at a certain BOP can be reduced only by reducing friction horsepower (lower RPM). Piston pilots climb, not because of engine efficiency, but because of the true airspeed gain at higher altitude due to lesser density which reduces aircraft drag.

If you fly using "square power," you have more BOP and correspondingly greater fuel flow at high altitude than you had at sea level. The Piper PA24-250 Owners Handbook lists 19.6" Hg. at 2,400 RPM as 138 HP at sea level. That same setting at 10,000 ft. is listed as 163 HP or an 18% increase in power. Since you can't create power from nothing, obviously the fuel consumption must go up. Piper lists this increase on the same page as 10.3 GPH increasing to 12.3 GPH for these two HP settings. Assuming 56 gallons of usable fuel, your endurance at 10.3 GPH is 5:26, but reduces to 4:33 at 12.3 GPH. There's no problem if you understand and know this. But if you proceeded on the assumption that square power gives the same consumption at all altitudes (and flew at 10,000 ft.), then you are short of fuel by 53 minutes. That is a considerable error.

After getting the aircraft "on the step" at cruise altitude with the desired RPM, your first move should be to set the altimeter momentarily on 29.92" Hg. and read the pressure altitude (the chart clearly says pressure altitude). Set the MAP for your desired BOP from the tabulated settings in the Piper Owners Handbook by interpolation to the altitude. Then compare the outside air with standard temperature and make the correction specified. By so doing, you are correcting the tabulation which is made for standard air (if the air is colder, it's heavier and you don't need that much MAP for the desired BOP). Your last step is the leaning process.

Square power is acceptable for a short flight if you don't have MAP tables, but it induces a considerable hazard for long flights. One must flight plan at a constant BOP, reducing MAP with altitude in accordance with the Manufacturer's power tables to produce a constant fuel burn with time. This is the only workable method. Square power produces unpredictable consumption. Editor Note: "Square" Power is a misnomer in this article and actually has no bearing on it. The reference should be "Constant Manifold Pressure"; the relationship of MR to RPM has only to do with BMEP (Brake Mean Effective Pressure).

MAXIMUM GLIDE RANGE

One of the advantages of an airplane over other forms of personal transportation is its speed. It takes less time to get from here to there. From the passenger's point of view, this is a measure of efficiency via relative speed. But there are other measures too, such as those relating to cost, which might make a flight seem very inefficient. So rather than compare aircraft in terms of efficiency, one should really be considering performance in association with a particular mission.

A member recently asked about the most "efficient" speed for a power-off glide, since this may be an important consideration in preparation for an emergency landing after engine failure, and is a speed not generally indicated in Comanche pilot operating handbooks. But again, because of altitude, weight, terrain, cloud cover, winds or other factors, what is the "mission?" Without power one's options may be greatly limited, but even then, would it be more desirable to glide at a speed that would result in the greatest distance covered per unit of altitude loss? Or at a speed that would minimize the rate of descent: i.e., provide more time before the ground comes up and contacts the aircraft? And, since we will have to land the aircraft "dead-stick" anyway, would it be to our advantage to stop the prop from windmilling? Efficiency is a relative thing and, in the practical sense, depends on a lot of variables. But to better understand the specifics, a review of some basic aerodynamics may be in order.

First drag is the enemy of most things we tend to think of in terms of efficient performance. In normal un-accelerated flight, drag is composed of two types: parasite drag and induced drag. Think of the words. A parasite is something that exists at the expense of another or is always attached to it (is parasitic). Parasite drag results from the displacement and disturbance of the air as the airplane is moved through it. It is a combination of form drag (aircraft shape / size), friction and the interference of airflow between the different shapes. It is always present during motion and increases from zero at a rate twice that of speed (varies directly with the square of the speed). The speed efficiency of the Mooney aircraft has been increased recently, principally through "clean-up mods" that reduce this type of drag. For any given configuration, there is nothing the pilot can do about it. It comes with the aircraft.

The other type, induced drag, is a by product of creating lift by the lifting surfaces (wings etc.). It is induced and can be controlled by the pilot through the angle of attack. Since the angle of attack is greatest at stall speed, near where the greatest lift is generated, and becomes less and less as speed is increased toward maximum, induced drag is maximum at stall and decreases with increased forward speed (constant altitude). Thus, induced drag varies indirectly with the square of the speed.

The total drag is the combination of the two principal types. As speed increases, parasite drag also increases but induced drag decreases. And, since they vary oppositely to each other, the total drag will be minimum at a speed where the two drag curves (drag vs. speed) cross. It so happens that this speed is where the induced drag is exactly equal to the parasite drag. It is also the speed that results in the maximum lift vs. drag, or maximum lift/drag ratio (Max L/D). An L/D curve is obtained by plotting both the coefficients of lift, Cl, and drag, Cd, vs. angle of attack. Dividing Cl by Cd at various attack angles will show that the Max L/D ratio, the peak of the curve, occurs at about 6 degrees with the maximum Cl near stall at about 18 degrees, depending on the airfoil type. More pertinent perhaps, is the total drag curve. This is obtained by plotting both parasite drag and induced drag vs. speed. Total drag is the sum of the two separate drag values at any given speed. The minimum total drag, the Max L/D, is at the low point of the curve and is at the same speed where the two separate drag curves would cross each other. Thus, the most efficient flight in terms of speed is at a speed where the total aerodynamic drag is minimum and the ratio of lift vs. drag is greatest. This is the Max L/D speed. So in terms of efficiency, it should now become obvious that the speed which results in the greatest difference of lift vs. drag will also be the "best glide" speed. This speed produces the maximum forward distance in comparison to altitude lost; i.e., the maximum glide ratio results in the minimum glide angle. The Max L/D ratio occurs at one, and only one, angle of attack and reduces from maximum as the speed is either increased or decreased from that point. And this one angle of attack is not affected by either weight or altitude factors. In other words, the Max L/D of a particular aircraft design is fixed with that aerodynamic configuration. The only thing that will change it is a change in either lift or drag coefficients, as with trim, the extension of flaps or landing gear during operation, or via airframe design modifications.

But weight does play a small part in the speed where Max L/D occurs. Referencing the two types of drag and the one angle of attack where the drags are equal, one can see that at a heavier weight, the aircraft must be flown faster to maintain the flight path with the same angle of attack. The Max L/D or curve doesn't change, but the speed at which it occurs changes. Conversely, a lighter weight will required a slightly slower speed but, again, the Max L/D or glide ratio still remains the same. The required new speed (at the same Cl) can be calculated by multiplying the original weight. Such estimate is necessary if the aircraft is to be glided at less than maximum gross weight, since it is the gross weight speed that is stated in a POH (if stated at all). For example, if the best glide speed is stated to be 100 MPH IAS at 2,900 lbs. GW, it would be reduced to about 93 MPH IAS at only 2,500 lbs. This is an average of less than 2 MPH reduction in speed for each 100 lbs. reduction in gross weight.

This concept is used to advantage in competition cross-country soaring. Such very high performance sailplanes, often with glide ratios (Max L/D's) of over 50:1, carry jettisonable water ballast to increase the weight during conditions when thermal ("lift") activity is strong. This enables them to glide in a straight line and through areas of "down" air at higher speeds than at normal weights. This minimizes the net altitude loss through the reduced time spent in down air and increases the average ground speed over the course. Then when the "lift" becomes marginal later in the day, the ballast can be jettisoned so as to allow the Max L/D to occur at a slower airspeed which will allow a shorter turn radius for spiraling in smaller, weaker thermals.

The concept of angle of attack vs. L/D also helps to explain why the true airspeed is higher at altitude vs. sea level. With the air being less dense at altitude, the aircraft must move faster through the air in order to produce the same C1 at the same angle of attack. This is another form of efficiency which will be covered in a future article.

But if the best glide speed (Max L/D speed) is not stated in the POH, how can it be determined without the benefit of lift and drag data? Anyone can determine it empirically through the development of a power-off polar curve. This is simply a plot of rate-of-descent vs. indicated airspeed. Climb to an appropriate altitude, allow the engine temperatures to stabilize and cool, then throttle back to idle. Adjust pitch attitude and re-trim to stabilize flight at various airspeeds over the range between stall and Vno (top of the green). Leave the gear and flaps retracted. Only a couple of points at the higher speeds may be necessary. Use a knee pad or tape recorder and note the rate of descent at each of these speeds. Also note the gross weight, typical altitude and temperature at the time for additional reference. The most accurate rate of descent is obtained via a given amount of altitude lost vs. time on a stop watch. Otherwise, use the vertical speed indicator but make sure it is stabilized each time since its inherent lag could cause appreciable errors. Just collect accurate data during flight and plot it later.

Such a flight exercise would be typical of an emergency engine failure situation but would not produce the L/D information representative of the aircraft's best aerodynamic qualities. This is because of the windmilling propeller. It is not only the drag of the propeller blades themselves, but in addition, the work necessary to turn the engine shaft against friction and the compression of the cylinders. This "drag" can be reduced somewhat, and would be something to consider in an actual engine-out emergency when full feathering is not available, by pulling the prop control to its minimum RPM (maximum pitch) position when at idle power. Drag can be further reduced by stopping prop rotation. With mixture (not fuel selector) in idle cut-off, increase pitch attitude to slow the aircraft sufficiently to stop the prop from turning (prop in max pitch), then proceed with the data gathering. But be sure to make the test flight over an adequate airport area in case of restart difficulty.

Later, plot the rate-of-descent data vs. airspeed on a piece of linear graph paper. The scales are unimportant. The resulting graph will be a curve with a high point near the low speed end. This high point is the "minimum sink" speed at the particular gross weight involved. Gliding flight at this speed will result in the minimum rate-of-descent and the maximum time aloft (in still air). The speed for "best glide" (max glide ratio, min glide angle) is the speed for Max LID which is always slightly faster. This speed, as well as the glide ratio and angle, is obtained by drawing a straight line from the origin of the graph so that it is just tangent with the polar curve. It will be tangent at only one point, the Max L/ D speed. Only this speed is the most efficient in terms of the maximum gliding range. The glide ratio is the numerical relationship of descent rate and speed, when converted to the same terms. The glide angle can be obtained from the trigonometric tangent of these terms. The relative glide angles (not actual) are shown graphically by the tangent line. (The maximum glide range vs. altitude shown in the Cessna POH for the T206 and the T210, laminar wing, converts to glide ratios of about 7.51 and 9.21, respectively, in clean configuration with prop windmilling. The Comanche should be similar, a Mooney slightly better.

Such curves and the concepts of Max L/D speed are not limited to gliding flight. They also have a direct bearing on powered flight with definite relationships to climb performance, Vx, Vy, endurance, range, etc.

FIG. 1 DRAG CURVE

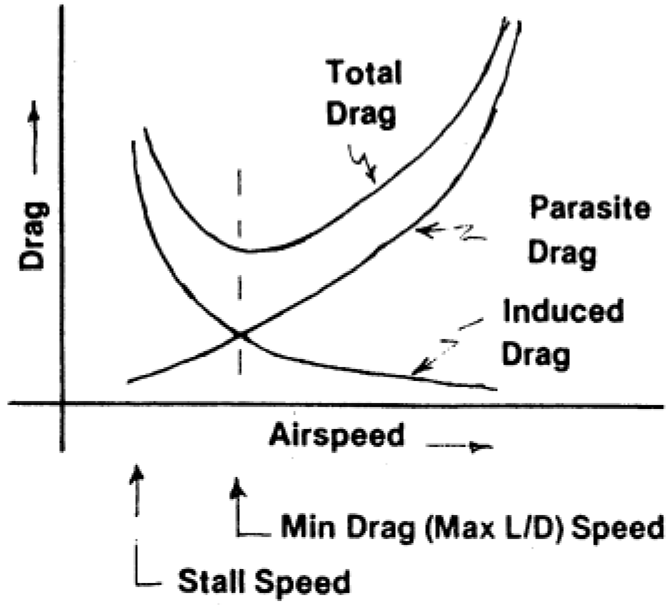
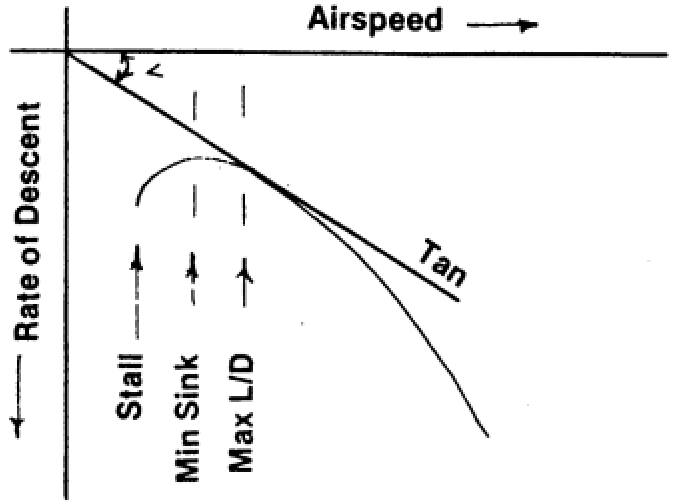


FIG. 2 POLAR CURVE



DETERMINING ENGINE OUT GLIDE SPEED

Doug Killough, ICS #07248

Around mid-December I started getting telephone calls from several concerned Comanche owners asking about the correct engine out glide speeds in their airplane. They told me their FAA approved manuals were not in agreement with the regular Instructors column by Tom Tweeddale and wanted to know which figures were correct. I looked in the December Comanche Flyer and read the article; "Engine Failure" by Tom Tweeddale, CFI, IA. In this article Tom states "...in my airplane, a '63 250 ... the best glide speed of 75 mph" and further "The 75 mph speed is the one which will give you the greatest distance power Off.."

Normally I would not take a fellow member to task but this and his previous articles make statements with such authority that pilots are likely to heed his advice. It further troubles me that he states that this advice has been disseminated to others through his seminars. Tom owns the FAA manual which I wrote that contains the correct information. I cannot in good conscience allow this information to go uncorrected as it directly involves flight safety.

Piper didn't tell us enough!
One of the reasons I developed the Comanche Pilots Operating Handbook was the lack of information available in our original Owners Manual supplied by Piper. Two of the missing pieces of information were the Best Distance and Best Endurance Glide Speeds. These are two separate and different speeds, each with particular applications. Like Tom, I own and fly a 1963 PA24- 250 and conducted much Flight Testing on that same model Comanche.

It is widely thought that Piper Aircraft did not conduct flight tests to determine the best engine-out glide speed for the Comanche. The fact is that these tests were indeed conducted toward the end of the airplanes production, on the Turbo 260C and a figure of 100 mph IAS was published in that Owner's Manual. This simple single speed was given, although my Turbo 260C POH shows speeds corrected for weight. Hardly anyone knows this because it is estimated that only two dozen of the Turbo 260C models were built, so very few people ever had reason to read the airplane's manual. Long before I engaged in the research necessary to produce the Pilot's Operating Handbooks for the Comanche and discovered this secret, I had need to determine the best engine-out glide speed for my own 1963 PA24 250. I am an (electrical) engineer by education, which turned out to be fortunate because I needed my engineering training to analyze the huge amount of technical factors and information in researching this subject.

What's "Best" Distance or Endurance?
I learned that use of the term "best glide speed" is a misnomer. However, generally speaking "best glide speed" is referred to as the optimum airspeed to achieve the maximum gliding range. As in most engine out situations, distance is the most significant factor. This speed results in the best glide ratio, that is the ratio of forward distance achieved for vertical distance used. Best glide ratio is obtained when the wing is operated at an angle of attack that will produce the best lift over drag ratio, or L/D max. This is also true of the airplane's best rate-of climb speed (Vy). Theoretically, optimum glide speed will be close to the best rateof- climb speed, but included among the variables in the mathematical formulas related to the best rate-of-climb speed are the elements of thrust and drag. Because efficiency is reduced by a dead engine (thrust is now zero) and airplane drag is increased (due to the windmilling propeller) optimum glide speed for any light airplane can be expected to be a value somewhat less than Vy. The generally accepted formula for estimating best engine- out glide speed in a typical reciprocating engine, propeller-driven, light airplane when it is not provided by the aircraft's manufacturer is to multiply by 1.4 times the clean stall speed (Vs1). Vy for my Comanche 250 at 2,900 lbs maximum allowable gross weight is 105 mph, and 1.4 times Vs I is 99.4 mph. Therefore, I was able to establish that the theoretical best engineout glide speed would be 100 mph IAS. Extensive actual glide tests conducted following standard flight-test procedures confirmed this figure to be correct. Glide testing done on subsonic aircraft by the military has produced graphs which show that a five percent deviation from best glide speed will not cause a significant reduction in glide ratio. Since optimum glide speed decreases as the airplane's gross weight decreases, this fact allows the specifying of glide speeds for a range of gross weights. An example of when use of a lower glide speed applies would be a solo pilot who is totally out of fuel. In this case the airplane would be several hundred pounds below maximum allowable gross weight, and use of an airspeed below 100 mph IAS would be appropriate. The rate of decrease in airspeed is approximately 2 mph for every 100 lbs below maximum allowable gross weight.

For the Comanche PA24-250, this results in the following table.
Airplane Gross Weight vs Optimum Glide Speed for Distance
Best Endurance Glide Speeds

2,900 lbs	100 mph	(87 kt)
2,700 lbs	96 mph	(83 kt)
2,500 lbs	92 mph	(80 kt)
2,300 lbs	88 mph	(76 kt)

The stipulation of a single figure for an engine-out emergency does not address many of the factors involved. Equally important in any discussion of engine out glide speed is the best endurance, or minimum-sink glide speed. This airspeed will result in substantially less gliding range, but will provide the maximum amount of time for the airplane to remain in the air. It is used when gilding range is not important (such as when directly over an airport at an altitude of several thousand feet AGQ, and time is important (such as when engine failure is due to having run a fuel tank dry, but then starting difficulty is experienced after switching tanks). Best endurance glide speed is theoretically equal to 75 percent of the optimum glide speed. However, operation at this speed is close to the wings level stall speed and a turn cuts the margin even closer to the edge. This condition could prove tragic for the pilot who is otherwise distracted by other factors during the emergency. For this reason, a slight compromise from pure theory will accomplish safer flight yet sacrifice very little in the way of endurance. To survive the engine failure the pilot must contact the ground while in control of the airplane. It is far more desirable to land short than to stall while operating on the ragged edge of the envelope. The generally accepted formula for establishing best endurance glide speed is to multiply by 1.2 times the clean stalling speed (VSI). This results in an airspeed of 85 mph IAS for the Comanche 250. It is safe to consider that at approximately 1,000 feet AGL, the pilot who is flying at the airplane's endurance glide speed should increase airspeed to establish optimum glide speed in preparation for landing. The additional airspeed will provide maneuvering control, and a safety margin to counter any unexpected low level wind shear. Also, if the airplane is operated close to the stall, there may not be sufficient airspeed with which to flare on landing.

The Right Stuff

In the interests of safety for our members, I have provided the following information from our Pilot's Operating Handbooks. This table gives the engine-out airspeed applicable to each version of the Comanche at maximum allowable gross weight. The figures are shown in both miles per hour and knots.

The FAA has reviewed these figures and found them to be acceptable for publication in the Pilot's Operating Handbooks that I wrote for the airplane.

Type	180	250	260	260B	400	30/39
Glide speed (Optimum)	95/83	100/87	100/87	105/91	115/100	110/96
Glide Speed (Endurance)	80/70	85/74	85/74	90/78	95/83	90/78

Configuration the difference between a 7-1 and a 13-1 Glide Ratio. In order to obtain the optimum gliding range the airplane needs to be properly configured. The engine-out glide ratio for the Comanche with the landing gear and flaps retracted and the propeller windmilling in low pitch is 10 to 1, or approximately two miles of gliding distance for each 1,000 feet of altitude above the terrain. Drag is substantially reduced when the propeller is put in high pitch (or feathered in the twin) and the glide ratio improves to 13 to 1. When the landing gear is extended, drag is radically increased and the airplane's glide ratio is reduced to approximately 7 to 1. For this reason, it is suggested that the landing gear and flaps not be extended in most engine-out emergencies until over the threshold of the landing area. Landing gear extension operating time is approximately 7 seconds, so be sure to allow yourself enough time to get the gear out.

Gear Up or Down when Off Airport?

Tom also stated that when landing in a rocky or otherwise rough area that the aircraft be landed gear up and some mention was made of damage to the aircraft. He reasoned that having a gear leg come off and losing directional control would be worse than landing gear up. I respectfully disagree, relying on some basic physics. (This is a somewhat subjective topic, and the decisions to be made in those moments are difficult and must be ultimately left to the pilot in command. To simply state that you should always land off-airport with or without the gear is not good advice.) There are many things to consider but one thing is clear, do not be concerned with hurting your aircraft. The goal is to survive, and if the aluminum can take the brunt of the impact instead of you and your passengers, don't worry about your plane. Your biggest loss will be the $500 or so for your deductible. The Insurance Company would rather pay out for bent aluminum than broken, or worse, people!

To minimize human injuries you want to spread the impact and deceleration forces out over the longest period of time possible. Fractions of a second can mean the difference between life and death. To stop dead with the nose in a small ditch from 70 mph could certainly cause incredible g forces. Without a shoulder belt, likely a fatal impact. On the other hand, if the gear took up a half second and slowed the aircraft down a little before coming to a halt, injuries would likely be less severe. The directional control issue is not as significant as it may seem. Like a car skidding on ice, once traction has been broken the mass of the moving object has the inertia to tend to continue in the established direction. Once a gear leg has broken, the digging in of the other is likely to fold it as well, and the direction of travel of the hull is not likely to be affected to any significant degree. The kinetic energy absorbed by sacrificing the landing gear could possibly make an off airport landing more survivable in some circumstances. Perhaps landing on a soft sandy beach may be more successful with the gear up? But, in a rocky field, landing gear up in a low wing aircraft with in-wing fuel tanks is just plain asking for a fireball, probably the greatest fear and traumatic experience any pilot could have.

TWIN STOP DISTANCE

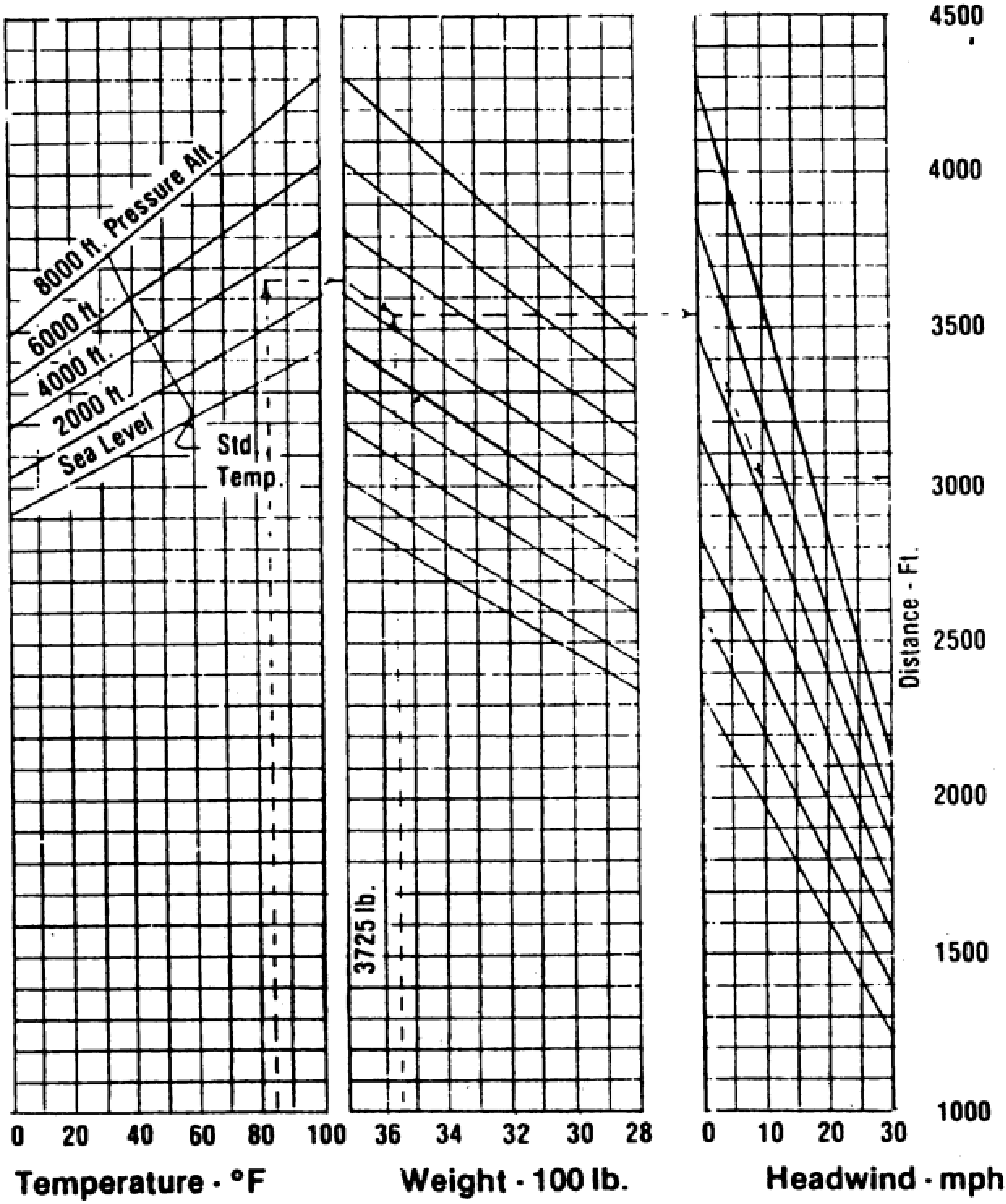
Data for the accelerate-stop distance of the non-counterrotating turbocharged Twin Comanche has not been available. This airplane has an FAA mandated minimum control speed (Vmc) of 90 MPH Calibrated Air Speed (CAS). Accelerate stop distance data does exist for the counter-rotating versions of the turbo-charged PA-30 and all PA-39 aircraft. These aircraft have a Vmc of 80 MPH as opposed to 90 MPH. Data also exists for the non-turbo-charged PA-39 (Vmc = 80 MPH) and the nonturbo- charged PA-30 (Vmc = 90 MPH). Using these published data and the fact that the accelerate-stop distance is primarily a function of the square of the velocity (W), I used two different approaches to calculate the accelerate-stop distances for the noncounter-rotating propeller turbo-charged Twin Comanche (Vmc = 90 MPH).

In one case, I used the ratio of turbo-charged PA-30's distance to non-turbo-charged distance at a given pressure altitude and temperature, and applied this ratio to the data for the non-turbocharged PA-30's (Vmc = 90 MPH) take-off distance. The second approach used the square of the velocity ratio (90/80) 2 to increase the published data for the turbo PA-30 (Vmc - 80 MPH). I found that the second approach yielded a slightly more conservative (longer) accelerate-stop distance. Recognizing that the Twin Comanche does not like to stay on the ground until reaching 90 MPH (producing very poor braking action at the higher speed), I constructed the accompanying figure using the conservative data. The data in the figure assumes that the turbos are adjusted to produce 29.5 inches of mercury manifold pressure throughout take-off. Anything less than 29.5 inches manifold pressure increases the accelerate stop distances.

I'm obliged to say that the data in the chart is to be used as a guide only, since it is not the result of carefully controlled tests, is estimated on the basis of rudimentary analysis (i.e., without varying aerodynamic drag or weight on wheels and not accounting for slight differences between PA-30 and PA-39 characteristics, etc.), and our litigious society (read as liability) considerations.

As a side note, I find that adjusting the turbos during static runup to produce 27 inches manifold pressure, produces approximately 29.5 inches manifold pressure early in the take-off run. This procedure limits the probability of over boosting the engines, but tends to increase the accelerate-stop distance, which is another reason for using the conservative values in constructing the chart.

ACCELERATE-STOP DISTANCE TURBO PA-30
Vmc = 90 mph, Flap 15°, Dry Level Pavement



CABIN SMOKE REMOVAL

Dense black smoke can fill an aircraft cockpit in a matter of seconds and has caused numerous accidents. The airlines have checklists for locating the source, and for removal by controlling air flow. Their crews have smoke goggles and oxygen masks enabling them to survive while they read the checklist. They receive training on the problem in a simulator every six months. Moreover, they have several people in the cockpit to solve the problem. The private pilot has none of these advantages, and the destruction of Monroe Casey's Comanche (see February 1988 Flyer) illustrates our difficulties.

Because of these differences, we must employ greater speed in taking action. We do not have time for long checklists. Since we may only have six seconds or less, we propose to cut-off all probable sources of cabin smoke, and get rid of it without bothering to find the source. We can find the source on the ground.

Examination of the ventilation systems for the various models indicates a serious problem on the early models prior to serial 1252 because of very limited fresh air intake. The heating and ventilating systems for the remaining models are much better, but considerably different. Some models have push-pull knobs to control heat and fresh air, and some have four levers at the lower right of the instrument panel. Some have air doors in the sidewalls at each seat, other models have none. The number and location of fresh air "eyeballs" in the ceiling varies from model to model. You should study your aircraft and the parts manual carefully to clearly understand how your system works. It is vital that you know:

1. How to isolate the engine compartment(s) at the firewall.
2. How to obtain maximum fresh air from all sources.
3. The location of the Generator CB.

The air sources (or ducting) for almost all of the panel mounted controls for heat, defrost, and fresh air are within the engine compartment, and all are a possible smoke source in the event of fire in that area. Closing off the firewall is our first step in keeping smoke out of the cabin. Your firewall should be as airtight as possible. Missing grommets and seals should be promptly replaced. Control doors should seat tightly. Control cables for those doors should be exercised frequently to remove corrosion and kept well-lubricated. Deteriorated rubber boots over the nose wheel steering-rods should be replaced.

Passengers should be briefed prior to take-off on how to open all fresh air vents. Sidewall doors provide greater air flow than the overhead eyeballs, but don't be concerned with the details of which comes first. Get them all open as fast as possible. Some of the eyeballs may have been installed incorrectly during reupholstering and should be checked. When correctly installed, the "On" position should blow air downwards on your face. If yours are backwards, unfasten the mounting screws and rotate them to the correct position. Remove any excess upholstery blocking the air passages.

All sources of un-contaminated fresh air should be opened fully, diluting the smoke to permit vision and breathing. Secondarily, this increases total air movement to assist in clearing smoke from the cabin. Flying with all rear-seat air vents fully open (consistent with reasonable comfort) should be considered. Reaching these vents quickly in an emergency may be difficult.

Smoke will flow from the point of entrance to the place of exit, and should be directed away from the pilot. Opening the small side window is an instinctive action, but this sucks the smoke directly to the pilot position, making matters worse. Do not open that window. In a similar manner, the air exit on the baggage shelf (in the baggage floor?) will draw smoke into the back seat. Since we intend to create a new air exit, these exits should theoretically be covered, but this is not practical.

To provide a large air exit and to direct smoke away from the pilot, we propose to open the main cabin door anytime you cannot see or breathe. It should trail in the slipstream open about 2 or 3 inches. Do not be overly concerned about "fanning" the fire. If you cannot see or breathe, nothing else matters.

This action creates considerable suction and should evacuate the smoke quite rapidly. Maurice asked for comments from pilots who have flown with a door open. Other than a slight increase in drag and considerable noise, owners of single engine aircraft reported no difficulties at all. Twin owners reported pronounced tail buffeting as the door opened further at approach speeds. Buffeting can be diminished by holding the door partially closed. Additionally, twin owners may wish to hold an extra 5 MPH (?) on final. Noise and buffeting is disconcerting and may effect your concentration. Anticipate this and fly the airplane! Some reassurance to the passenger is indicated.

An electrical fire behind the panel is perhaps more likely than an engine fire. An electrical short can be quickly eliminated by pulling the generator breaker and turning off the master switch, but you may need the radio to declare an emergency. If this is the case, tell the tower you have an emergency and command them to clear all runways (Bill Creech's article in the February Flyer is correct). Inform them you are turning the radio's off. Land as quickly as possible regardless of whether the smoke clears or not (if the smoke source is within the engine compartment, you may shortly experience other serious problems).

Lacking information on the source, we cannot list the optimum order in which the items should be accomplished, but since you can close the controls which isolate the engine compartment in perhaps one second, that seems a reasonable first step. The following drill should be committed to memory, practiced, and accomplished as rapidly as possible. If the source is electrical, there is a chance that step 5 may not be necessary.

1. Close off firewall (levers or knobs).
2. Command or open ALL fresh air vents.
3. Declare an Emergency and inform tower no radio.
4. Pull Generator CB ... Master switch OFF.
5. Open cabin door anytime you are unable to see or breathe. Fly the airplane.
6. Land as soon as possible. Hold an extra 5 MPH on approach.

If you are flying IFR, you obviously should seek an area of VFR conditions. If you are unable to land immediately and the problem was electrical, you may be able to get one or more radios back by the following procedure:

1. Turn off all lights and radio's individually.
2. Turn master switch ON and wait five minutes.
3. If smoke resumes, abandon the attempt. Turn master switch off. Do not complete steps 4 and 5.
4. If smoke test is satisfactory, turn on the desired radio and again test for smoke for five minutes.
5. If smoke test in item 4 is satisfactory, operate radio on battery power. Do not reset generator CB.

Modern radio equipment draws very little amperage and the battery should last until you find an airport. You might also wish to try to regain a VOR and the transponder, but don't push your luck too far. The object is to get it on the ground.

Most fire extinguishers are not approved for use in confined spaces (Halogen 1301 is the least toxic). But if your pants have caught fire and you are 15 minutes from a suitable airport, we are not going to tell you not to use it. Perhaps you could put the fire out, and re-ventilate?

BROKEN THROTTLE

In April of 1987, following work on a very beautiful April day, my wife, Nancy, and I departed our home field at Beach City, OH, for the Carroll County Airport for dinner, about 25 nm distant. Carroll County has a single 4,300' runway with a drop at each end. On short final, as I attempted to further retard the throttle, I noted a strange looseness and pushed the throttle in to climb power for a go around to resolve the "looseness." After the gear and flaps were up, I gingerly tried to retard the throttle. Nothing! It was obvious that the throttle cable had broken and there we were looking at power settings of 25 square.

I climbed to 2500' (about 1500 AGL) and contacted Akron- Canton Approach (about 35 miles distant) and advised them of my problem. I told them I wanted their longest runway and would appreciate their getting a mechanic on the line to offer any suggestions as to how to slow down the airplane. I was indicating 172 MPH in level flight. Shortly after, an unknown voice came on the frequency (obviously from another aircraft) and announced that he was a high time Comanche pilot and that the only thing I could do was to milk the mixture, retard it until the engine was about ready to quit and then to richen it slightly. Shortly after that, Approach advised me to contact Mckinley Unicorn at Akron-Canton Airport, that there was a mechanic standing by. The mechanic was Jerry Patterson who told me the same thing about the mixture. He came back about 10 seconds later with an afterthought not to attempt it until the runway was made just in the event the engine might stop and not restart because of a vapor lock.

Approach set me up on a five mile final. I pulled the nose up, got the speed up to 160 and dropped the gear. The flaps went down at about 140 and we came in over the numbers at a speed I would estimate at about 125. I was not looking at the gauges at that point, only the runway. I tried to hold the aircraft about 2' above the surface and then started milking the throttle. Finally, when I felt I had good control of the aircraft right above the runway, I closed the mixture, the engine stopped and shortly we settled to the runway in a perfect landing, using only about half of the 6,000' runway. My biggest concern in the landing was ballooning with the power off but this never occurred. The emergency vehicles then came out and I was asked how much fuel I had. I replied "55 gallons" and pulled the throttle knob and shaft out of the panel and showed it to the officer and advised him that was the culprit. The throttle cable had parted about one inch from the shaft.

At the time I contacted approach I had not made any decision on how to handle the problem. The excellent advice from the "high time Comanche pilot" was welcome advice which set my thinking along the proper procedure. I do not know who that person was but would appreciate hearing from him if he reads this. Perhaps it was the ghost of Max Conrad protecting a Comanche??

I credit myself for having the good sense to "go around" at Carroll. I could not have reacted quickly enough to get the aircraft on the ground and stopped before the end of the runway. The 10 minute flight to Akron - Canton gave me time to collect my thoughts and the opportunity to obtain some sound advise and make a long, shallow approach.

The following day I heard from FAA. I had not declared an emergency, but they wanted to know in detail what happened, all serial numbers, time on A/C and engine, time SMOH and SPOH, date of my Medical Certificate and when I had my BFR. Fortunately, all was OK and I never heard further from them.

FUEL MANAGEMENT

Don't run a fuel tank dry in flight. This may seem like a common sense statement. After all, to those pilots not initially trained in gliders or sail planes, or to those who never practice engine-out emergency procedures in either single or multi-engine airplanes, the sudden and total loss of power along with its drastic change in sound, vibration and aircraft attitude, can be a very surprising and scary thing. And potentially dangerous! Thus many pilots, particularly newer ones, would generally never consider intentionally allowing a fuel tank to run dry in flight so as to cease engine power. Yet many do on a regular basis, and tempt fate by doing so. If nothing else, it scares the hell out of any passengers! And who among them would ever want to fly again without being drugged first? Yep, it takes all kinds. But the purpose of this article is to reduce those potential numbers by making pilots more conscious of their responsibilities, thereby enhancing flight safety as well as encouraging non-pilot passengers to more readily accept and enjoy flight in non-airline aircraft.

Pilots often take a lot for granted, partially because of their familiarity or expertise, but they also often tend to be ignorant or non-appreciative of passenger's concerns. A conscientious pilot will do what he can, within practical limits, to alleviate his passenger's fears by displaying a professional and safety conscious attitude and adherence to accepted good operating practices. Intentionally running a tank dry is not one of them!

What if the gauge (supported by your personal pre-flight knowledge) shows the tank to be full or have adequate fuel remaining? You intentionally run one tank dry then switch to the other and there is no fuel. This is exactly what precipitated an outstanding AD (Airworthiness Directive) years ago on early model Comanche fuel vent systems. Seems like the pilot thought there was fuel in both tanks, and the gauges indicated so, but total fuel exhaustion caused him to belly it in off airport. The rubber fuel cells are attached to the upper wing skin by means of small clips. Unbeknown to the pilot, some of these had come loose, allowing the cells to partially collapse. Thus, at takeoff, the cells actually held less fuel than the pilot thought, and during fight the float type sender units also registered more fuel due to the diminishing size of the cells with their partial collapse. The subsequent AD required 100 hour inspection of the fuel cell retainers or modification of the vent system with a type that would provide pressure and preclude cell collapse even if the retainers came loose. Don't trust the gauges without verification!

Most importantly, proper fuel management requires that the pilot KNOW how much fuel is on board prior to flight - by switching tanks appropriately and well prior to fuel exhaustion - and later verifying both fuel tank capacity and consumption rates by measuring the amount of fuel remaining after landing and by how much it takes to refill.

The following key points will ensure good fuel management:

1. Investigate the fuel system of your aircraft. Learn where all the components are and how they operate, including all valves, pumps and vent systems.
2. Properly maintain the fuel system!
3. Drain all fuel from all tanks and refill while calibrating the gauges and tank capacities. Make sure that the maximum fuel capacity (as well as the type of fuel) is properly placarded next to the filler opening of each tank, as certified (see flight manual).
4. Determine and note the maximum ACTUAL fuel capacity of each tank when sitting in a typical ramp position. Note that this is the maximum that can ever be put in the aircraft, NOT what it could hold in level flight, and is usually LESS than the placarded maximum amount.

5. Lean the fuel flow in accordance with the POH or manufacturer's recommendations, carburated or injected. Do not be afraid to lean at lower altitudes and during climb as long as the power setting is 75% or less and the CHT and oil temps are in the green.
6. Develop a method to keep good track of fuel usage during each flight leg. Pay attention to time en route vs. average fuel consumption rate(s) and don't rely on the gauges. Even calibrated gauges are only approximate at best, and in some type of aircraft are next to useless - especially if they consistently hang-up on the high-side.
7. After landing, develop the habit of "sticking" each tank with your calibrated dowel prior to refilling. Use this information to double check against the associated gauge, and add the figure to the actual amount it takes to top off the tank to verify maximum tank capacity.
8. Turn on the fuel aux. pump prior to switching. This will assist in re-establishing a strong fuel flow should a break in fuel flow occur.
9. Pre-flight your aircraft, including fuel drain samples and by looking into the tanks, and flight plan properly (see FAR 91.5). And - NEVER RUN A TANK DRY.
10. It's also a good practice to always ensure that the tanks (at least the mains) are fully topped off prior to any cross country flight, unless weight considerations dictate less. There could come a time, due to weather or other unpredicted adverse circumstances, that the last bit of fuel could be worth its weight in gold! Now, is there any excuse for running out of fuel, or a need to run a tank dry?

FUEL MANAGEMENT

I have been reading with great interest, the debate on when to switch fuel tanks in order to get the greatest range and passenger comfort. After all, we Pilots in Command know what we are doing, and the moment of quiet doesn't seem to bother us. However, over the years (just to let you know, I'm no newcomer), I have found what seems to me to be a better way. Some years ago I installed a Hoskins Fuel Computer (337 issued as I fly an old O-549 with a carburetor). I made up a form that I use on every flight.

I use the same sequence of fuel tanks all the time - start up / run up and take off on the left main tank and climb out / cruise to the next cardinal time, i.e.; hour or half hour clock time. When that time is reached, switch to left aux. (outboard) tank. At switch time, I check the Hoskins for time and fuel used (in gallons) and list this figure on my little form. This now gives me a record of how many gallons are left in the left main tank. Usually, it comes out to about 9 gallons in 0:40.

By using the Hoskins and leaning to a known fuel flow of 12.5 gallons per hour, I can now time the aux. tank to 1:12 using 14.7 gallons. This accounts for the 15 gallons available in the left aux. tank. Next, switch to the right aux. tank and another 1:12 and 14.5 / 14.7 gallons. This drill is repeated to the right main for 2:25 and if I am not at my destination by then, I still have at least 21.0 gallons left in the left main, at 12.5 gallons per hour for 1:40. Of course, if the time / distance requires a full load of fuel (at my age, I schedule a rest stop), I do always keep the legal requirements for alternate, and holding. But generally over 5 hours of flying and I am ready for at least a cup of coffee. The Hoskins has been a great addition to my panel, and does take the anxiety out of long flights, as it allows me to monitor the fuel usage. It's also fun to tell the line boys how much it will take to fill up again. (Usually the Hoskins shows about 1 to 1 1/2 gallons more used than the refill.) I know not everyone can use a fuel computer, but for those who can afford one, it's a real nice thing to have. For those who fly a fuel injected engine, the accuracy is much better.

I also made up a chart that I use for zero wind flight planning. I don't claim to be an engineer or anything like one, but these figures have worked for me and 7172P for the last 18 years - maybe it will help someone else.

RUN-UP OPERATIONS

A snap judgement about a bad run-up can cost needless downtime. How to make the critical go / no-go decision? Here are some pointers:

Every pilot has experienced the "not quite right" run-up - the one that produces more than a 50 RPM difference between magnetos, or that shows a more than 150 RPM drop on one or the other mag. It's sad that this statement can be made at all. But until electronic ignition becomes a commercial reality for small planes - which means, in turn, an overhaul of the current tort law system as it pertains to product liability - we're stuck, basically, with Stone Age ignition.) The question is, what do you do next - - short of simply handing the keys over to the FBO - after you decide that a run-up "isn't quite right"?

Most "bad run-ups," of course, are not as clear cut as the above example. In fact, the trouble with standard pre-takeoff run-up technique as practiced by the majority of pilots today is that strict adherence to a "cookbook" run-up technique can result in dangerous warning signs going unheeded and harmless irregularities causing needless alarm. The fact that a mag drop is within the 150 (or 175) RPM range allowed by your owner's manual doesn't necessarily mean the ignition system is safe to fly. Conversely, a 175 RPM drop isn't always indicative of trouble. But if you're a "cookbook pilot" who follows POH checklists in knee jerk fashion, without stopping to think about what you're seeing and hearing, you'll be fooled at least some of the time.

BACK TO BASICS:
First, let's recall why we do a run-up at all. We do a run-up to check the integrity of the ignition system. Since there are two ignition systems, one system can (and should) be used as a cross-check against the other. If both systems are in a similar state of repair, and the mags are properly synchronized, then such normal occurrences as breaker point erosion, cam follower wear, and resulting internal timing drift will be of the same magnitude for each magneto, and the mag drop on each system will be comparable. Should a truly abnormal condition develop (such as a cracked distributor block), there will be a definite split - a divergence - of the mag drops, and the pilot may be forewarned of serious trouble. This is why most handbooks put particular emphasis on the difference in RPM drops on two mags (which should be no more than 50 or 60 RPM). The actual magnitude of the drops isn't as important, because the absolute RPM decline is a function of density altitude, the run-up RPM chosen, whether you're facing into the wind or downwind, oil temperature, fuel metering (rich mixture versus lean), and other variables that change from day to day and flight to flight.

Also more important than the actual magnitude of the RPM drop is the quality of the drop in terms of roughness / smoothness, consistency from flight to flight, and (if applicable) EGT indications. In some planes, it's entirely normal to witness a 175 RPM drop on each mag, every day. But on a plane that has been showing a 75 RPM drop (and, say, 10 RPM difference between mags) every flight for the last ten flights, a sudden appearance of a 175 RPM drop on one mag (and not the other) would definitely be cause for concern. Consistency in mag drops (as in so many things) is of utmost importance. (On rental airplanes, it probably should be logged by each pilot, on each flight, on each day's squawk sheet.)

The main thing to look for is a smooth RPM drop, of a magnitude consistent with previous successive run-ups, and with little or no RPM difference between mags. (Some engines, such as the Lycoming O-360-A3A, habitually experience a greater drop on one mag than the other, due to peculiarities of the accessory drive system. Also, the very few planes and helicopters that use an unorthodox harness wiring, i.e., with one mag firing all the top plugs and the other firing all the bottom plugs - and those designed to use uneven mag timing, such as the Continental C-85, can expect to have some built-in "split" between mags. Everyone else should expect - and strive for - no more than 50 RPM difference between mags.)

While we're on the subject of big RPM drops versus small RPM drops: Forget about the myth that a small mag drop is inherently better or more desirable than a large mag drop. A small RPM drop means advanced timing - maybe too advanced. Why? The typical "quick fix" for a mag that's giving "too much RPM drop on run-up" is for the mechanic to loosen the hold-down nuts and "bump" the mag a few degrees in the advanced direction, then re-tighten the nuts. This is called bumping the timing, and it's a practice that's as widespread as it is ill-advised. (See Continental Service Bulletin M68-2. Rev. 1.) Improperly advanced timing also comes about inadvertently, through parallax sighting errors, when timing is set by the "notch on the pulley" method. (Whenever timing is adjusted, it should be done by the positive-stop-pin or "top dead center locator" method, with a dial on the prop. Example: the TP-102E Aircraft Timing Indicator, $46 from U.S. Industrial Tool & Supply, 15135 Cleat Street, Plymouth, MI 48170, 1-800-482-4167.) Don't accept improperly advanced timing. If your mag drops are consistently less than 50 RPM, check into it.

BORDERLINE CASE:
The typical borderline go / no-go run-up is one in which the engine runs a little rough on one mag - perhaps with a 25 or 50 RPM greater drop than the other mag, perhaps with no noticeable RPM difference. The roughness may be due to plug fouling. Then again, it may not. What do you do?

If you know the plane (and engine) well enough to know that it is, in fact, plug fouling, try a quick burn-off. (But don't take all day.) Run the engine at 1,800 RPM or so (both mags on-line) and slowly lean until best RPM is reached. Hold it there about 10 seconds. Lean just slightly beyond best RPM (the engine may stumble), then slowly bring the mixture back in to full rich; and recheck the mag. If it's still un-flyable, taxi back in and shut down. Don't spend all day straining at the brakes, kicking up dirt with prop, leaning the engine until you (and your valves) are blue in the face, etc. It's not good practice.

My 182 used to give me a bad run-up about every tenth flight; it seemed I couldn't do more than 10 hours after a plug cleaning before the plugs would be so dirty again that I couldn't burn the crud off them on a lean run-up. (Some of the crud was lead, but much of it was oil. The engine used a quart every two or three hours, until I topped it.) Finally, I got wise. First, I started using TCP in the fuel - even though, at the time, I was still often able to get 80/87 av-gas. Alcor TCP Concentrate had an immediate salutary effect, in that I was able to go about twice as long between bad run-ups. The TCP not only scavenges lead, but it forms deposits (on the plugs) that are less electrically conductive than the deposits that normally form. Plug fouling became less of a problem for me.

But I got wise in other ways, too. In addition to using TCP, I began doing lean shutdowns at the end of each flight. "But isn't every shutdown a lean shutdown?" you may ask. Not really. What I mean by a "lean shutdown" is running the engine at 1,100 to 1,200 RPM, leaning for best RPM, and keeping it right there for 20 seconds or so before pulling the red knob back to the stop. This heats the plugs' firing ends hot enough to burn off carbon deposits (from oil and fuel fouling) and leaves the plugs in an electrically trim shape for the next start-up. The next start is not only easier on the starter motor, but easier on the plugs and mags; the plugs misfire less while cranking, and give a better run-up on the next flight.

Finally, at some point, I got totally wise and started doing what I've been preaching to pilots ever since: Lean the engine on the ground. You cannot hurt your engine by leaning it when it is producing idle power (or there abouts). Engines are set up tremendously rich for idle. The only reason for this is to ensure smooth acceleration when you open the throttle. (If the mixture were stoichiometric, rapid throttle opening would cause a sudden leanout, and the engine would stumble and die.) The carburetor or injector is set up to be rich at idle at sea level. But throw a little density altitude into the equation, and you're suddenly super, duper, rich. You can take away the super, and the duper. Just lean during tax! (go for the best RPM), and enrichen before you advance the throttle for run-up.

FEAR OF REJECTION:
No pilot likes to reject a run-up. Most of us, accordingly, are guilty (from time to time) of going ahead with a takeoff even when we know the mag check didn't meet book criteria. It's a bad habit to get into, however. Particularly if you're taking passengers. Don't push. Accept the fact that you're going to have to reject a run-up now and then. It's a fact of life in the world of breaker points and high-lead fuel.

Remember that the "mag check" isn't just a check of magnetos; it's a check of the entire ignition system (and by no means a fool proof check, at that). That slight stumbling you thought was plug fouling might actually be a bad cigarette spring or tower contact, or harness breakdown, or any of a dozen other things - some of which might get worse, not better, as you push the throttle to the wall on takeoff.

Pilots, as a group, are incredibly lax about magneto maintenance. They expect magnetos to function flawlessly (with no maintenance) for periods of 500, 600, even 1,000 hours or more. It doesn't occur to most pilots that tungsten breaker points pit and wear out, that magneto bearings dry up and go bad, that coils crack or go on the fritz for no apparent reason whatsoever, that hermetically sealed capacitors often corrode over, sealing noxious ozone and other ionization products inside the mags, leading to rapid deterioration of metal parts. Pressurized mags are even worse. The heat from deck (turbo) air, which is used to pressurize the mag housing, greatly accelerates wear and corrosion inside the magneto. The upshot of this discussion is that if you aren't having your mags opened up and looked at every 100 hours (or at each annual), you're taking chances needlessly.

Mechanics, on the other hand, are incredibly lax (this author finds) about keeping cigarette springs and terminal wells clean. Undo the terminal connections on your plane and you'll see what I mean. Spring contacts are usually black and pitted to the point where you can't see bare metal any more. Look down inside each plug (from the terminal end) and you're likely to see a black streaked mess, with obvious pitting on the resistor screw. "Why make a fuss about this", you ask? "After all, the magneto is fully capable of overcoming the added resistance of a little bit of corrosion in the well." But that's just it. The magneto (specifically the coil, the points, the capacitor) has to work harder to make the "front end" of the ignition system do its job, when springs and contacts are dirty. The high-tension system becomes more highly tensioned, as a result. (And the higher tension certainly doesn't do anything good for ignition harnesses.) No system is more vital to safety than your ignition system. Scrimp on maintenance anywhere else but here. Get your priorities in order. Put a few bucks into magneto maintenance (and harness replacement, when necessary) - invest in a little TCP and TLC - and your run-ups will be become music to the ears.

MANUFACTURERS ADVICE:
"The magneto-check RPM should be in accordance with the applicable aircraft flight manual, with the propeller control in low pitch, high RPM position. Move the ignition switch first to 'R'

position and note RPM, and then move the switch back to 'BOTH' position to clear the other set of plugs. Then move the switch to 'L' position and note the RPM. The engine should run smoothly when operated on one magneto and the difference between the two magnetos should not exceed 50 RPM. When moving the switch from 'BOTH' to either 'R' or 'L', the drop in RPM should be smooth and not exceed 150 RPM.

Arbitrarily checking the magnetos at cruise power settings should be avoided as the rapid changes in combustion temperatures and pressures and the increased possibility of dangerous backfire could be detrimental to the engine and related equipment. ("From Continental S.B. M80-27".)

OPERATION TIPS

Following are some dos and don'ts for operation of reciprocating aircraft engines that will reduce engine problems and enhance engine longevity and aircraft safety: Ground Running: Modern aircraft engines need air flow for proper cooling. Avoid long ground runs. ALWAYS fully open cowl flaps for ALL ground operation. NEVER warm up with cowl flaps closed.

Air Speed in Climb: Climb at less than recommended air speed results in inadequate air flow over the engine, hot spots and excessive wear. Many pilots use a climb IAS of a few knots above the book recommended number. A little loss in rate of climb is made up in miles gained - and the engine likes it better. Throttle Movements: Rapid throttle movement, on the ground or in the air, will cause different parts of the engine to expand and contract at different rates as engine temperatures change and cause binding and twisting, resulting in excessive wear each time it is done. Throttle chopping is a prime cause of cylinder head cracking and other engine problems. Always use smooth throttle movements.

Letdowns: Over cooling the engine during descent results in lead fouling and excessive wear. Lean for smooth engine operation during descent. The ideal descent from cruise altitude is to reduce manifold pressure two or three inches and descend at about 300 FPM. Trim slightly nose down and let the air speed build up only slightly. A good rule of thumb to calculate start of letdown point is: Six percent (x .06) of ground speed for each 1,000 feet of altitude to be lost gives the distance from destination to begin, i.e., 150 GS x .06 = 9 miles x 5,000 feet (cruise altitude above traffic altitude) = 45 miles. Begin descent 45 miles from destination. Keep the engine warm - NEVER Let the propeller turn the engine.

Cowl Flaps: Leave the cowl flaps CLOSED during letdown and approach. If you must go around, the engine will be warmer to take power. Most engines will not overheat unless climb is extended, then there is plenty of time to open the cowl flaps. Mixture Control: Prolonged, excessively lean mixture at cruise power will eventually burn exhaust valves and pistons. In extreme cases, it can cause destination, resulting in piston collapse or cylinder head failure. Rich mixture contributes to plug fouling, carboning and ring and valve sticking. Follow the handbook instructions for your aircraft and engine. Idle Mixture: Maladjusted idle mixture can cause a host of engine problems, fouled spark plugs, sticking valves, burned valves, stuck piston rings, carboned pistons and cylinder heads, blackening of oil and even wheel brake problems - if you kick up the RPM a little during taxi to prevent plug fouling. Idle mixture is easy to check - see CHECK IDLE MIXTURE under Maintenance Tips.

Carburetors: Improper carburetor calibration has on occasion been found to be the culprit causing excessive engine wear. Keeping track of fuel consumption is one way a pilot can detect this potential problem.

Soot in Exhaust Stack: Occasionally, swipe your finger inside the exhaust stack. Excessive or increasing soot buildup indicates ring blow-by and trouble down the road.

Cold Weather Starts: Oil is partially congealed and slow to begin circulation. Care must be exercised in use of power until the engine has begun to warm and oil pressure has stabilized. Heavy priming will wash oil from the cylinder walls and result in excessive wear - not to mention the fire hazard.

Inactive Engines: Engines that are used regularly last longer. Short ground runs only add to internal corrosion, since oil must be brought to operating temperature to boil out the water and acids. Engines expected to be inactive a month or more should be "pickled" in accordance with the manufacturer's instructions. Listen to Your Engine: Engines can talk - if you will listen! Be alert for gradual changes in engine sounds, oil consumption, fuel consumption, changes in temperatures and pressures. The engine just might be trying to tell you something. Engine failures without warning signals are extremely rare.

PERFORMANCE CHARTS

KNOWING YOUR AIRPLANE (THE EASY WAY)

I have a confession to make. I like to read and workout the performance graphs in aircraft manuals. At first I didn't worry. I thought that I could quit at anytime, but now I admit that I need help. So I'm forming a support group for pilots who like to read all those graphs. It's called Nobody Ever Reads the Dumb ThingS. The problem is that I don't think that there are enough of us to form a group. Admit it, when is the last time that you worked a Weight and Balance problem or computed your takeoff distance. It always amazes me how many students go to take their private check rides, in an airplane that usually represents 100% of their flight time, and yet they have no idea that they have been over gross in that 152 every time their instructor was aboard. They probably will be again when the examiner hops on for the check ride. You airline types don't need to feel too superior here, because the company does your calculations and they just guess at the passenger weights anyway.

Yet all of us would agree that there is some real life-enhancing information that we should know contained in those funny charts. Here are some suggestions for showing you how you can spend one (maybe two) evenings going over the charts and perhaps never have to do it again. Don't rush out and start digging for your handbook. Sit down and fill out this questionnaire first. Don't worry, you are not going to show these numbers to anyone and you get to throw away the evidence.Your weight (Be honest and count your clothes and use earth normal gravity)

1. Your frequent flyers' weight (Aren't you glad you can throw this paper out?)
2. Your flight bag (Mine weighs in at 32 lb. - more than I usually pack in clothes)
3. Your frequent flyer rear seat passengers' weight
4. Full fuel weight (I also use Aux. & Mains only)
5. Least fuel on board weight (One hour for me)
6. Altitude of the airport you use most often
7. Highest elevation airport that you frequently use (If different from above)
8. Highest temperature that you would normally expect at departure (A hot summer day)
9. A low-end winter departure temperature
10. Your aircraft empty weight, C.G., etc.
11. Weight of cabin items - Headsets, window screens, 02, books, Kleenex, rags, spare bulbs, tools, that rug in your luggage compartment, aircraft papers, manuals, magazines, etc. (I put everything in a box at one annual and weighed it - 48 lb !)

Now go and dig up your Operating Manual. Make at least three copies of each of the charts. Get a soft pencil (you do everything in pencil then trace with the appropriate pen), a good eraser, a red and a light blue felt tip pen, scissors, and clear tape.

It is time get to work. I'll use the Accelerate-Stop chart for my example. What I suggest that you do is figure a normal worst case example and a normal best case example for you and your airplane for each of the charts. The idea is to have a normal operating set of parameters. Use the blue pencil for the most advantageous normal plots. For example, winter with 10 kph wind. Use the red pencil for the least advantageous plot. For example, 80F, no wind, and heavy normal gross. Remember normal conditions not the extremes. Did I say 'normal' conditions enough times?

The next modification that we can make to some of the charts is to adjust the scales for 'Real World' conditions. Again let us return to the Accelerate-Stop chart. To determine our best and worst case normal situation let's consider the facts. My home base airport is relatively flat and my airplane is as well maintained as any I have seen, and I actively train to be as proficient as possible. However an objective look at my situation would, I believe, require some adjustment to the charts. First of all is the element of surprise. How quickly will I recognize the need to abort? Remember the test pilot knew what was coming. There is also the strong possibility that the failure or problem won't be complete or total, hence more difficult to detect. Next I don't know how hard I have to brake. Can I can keep from locking the wheels as the threshold rapidly fills the windscreen? Recent accidents at our airport show that most pilots go off the end with the wheels locked. How much will my brakes fade? I don't know these things because I don't practice them. I don't want to subject my airplane to that kind of abuse. I would, of course be willing to rent your airplane to try all this neat stuff, but I suspect that you feel the same way that I do. Will I do all the right things in the right order without hesitation? I think so, but in the crunch who knows? It might be good to have a "safety factor".

Here is how I add my safety factor to the charts. Cut out the Distance Scale from another copy of the same chart and position it over the existing scale in such a way that it reads 40% higher (tape it in place at the top like a flip chart). That is my safety factor (for this chart) forty per cent. We could get into a long, long discussion (and I would like to - I'll even buy the beers at the next Fly In) on why I feel that is a reasonable number, but what is really necessary is that you decide what your handicap should be. Make sure that you can live with it (pun intended). Of course there are many other factors that could go into your handicap. Here are a few suggestions:

	C	ondition of the Aircraft
Time	**O**	f Day
Airport Elevati	**O**	n
Pilot S	**K**	ill
Practic	**E**	
Pilot Min	**D**	Set or Attitude
Aircraft Confi	**G**	uration
Runway Envir	**O**	nment
L	**O**	ading & C.G.
Weather Condition	**S**	
	E	ngine Health

With all this accomplished what have I gained? This procedure has allowed me to concretely and visually display my normal personal performance parameters. I no longer have to do a complete set of calculations every time I fly (as if we did them anyway). I do know that if I put on a heavier load, the day is hotter, or the field elevation is high, then I still need to do a chart work-up. Of course we knew that anyway. What we've added is: how far out on the limb we are before we get to the exotic conditions. Sometimes you may get some interesting and unforeseen results. For example I have learned that on a hot summer, no wind day with my usual long x country load of people and fuel on board that my airplane and I probably cannot accelerate to Vmc and then stop without catching a green light on the highway down the road some from our runway (And I am NOT at full gross). Does this mean I shouldn't fly? That's my personal decision but at least I can make it with the facts, and explore all the alternatives. Wouldn't you like the same advantage?

One more thing is a real help with all of this. If you have a computer, enter your weight and balance information into a spread sheet. You can "What If" to your heart's content. I have an IBM compatible and I use Lotus 123 for Windows. If you send me a disk and your address I would be happy to give you a copy of my spread sheet file. (send to: Tom Srachta, 1110 Country Drive, Shorewood, IL 60435.) You can easily modify it for your aircraft.

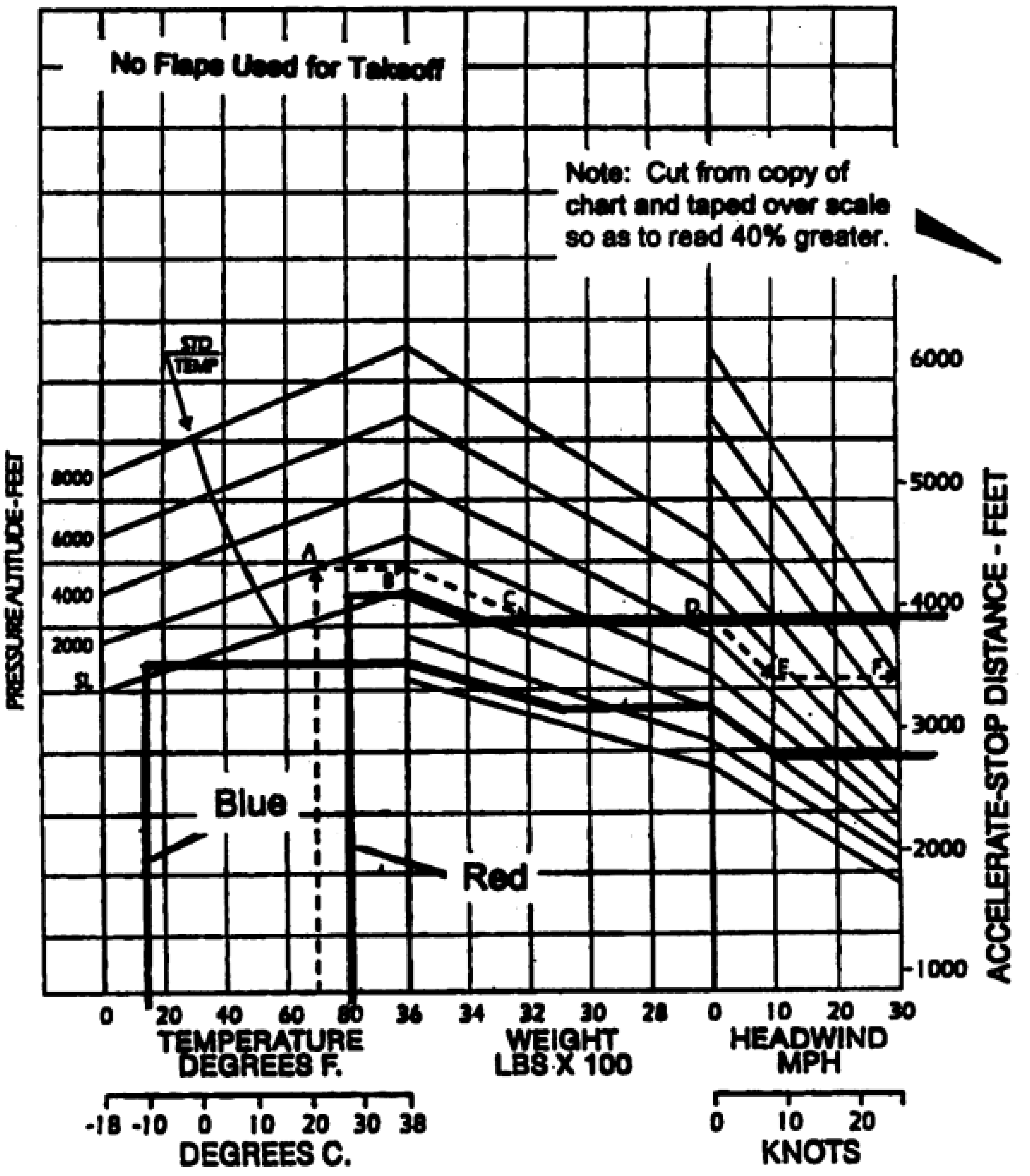
You'll also get a complimentary membership in N.E.R.D.S.

My thanks to Doug Killough and his fine Operating Handbook. No Comanche should leave home without it. Any modifications or assumptions made regarding the interpretation or use of these charts is strictly mine and you should not blame Doug in any way.

ACCELERATE - STOP DISTANCE

WING FLAPS: 15 DEGREES
FULL THROTTLE AND MAX RPM
BOTH THROTTLES CLOSED AT DECISION SPEED

RUNWAY SURFACE: PAVED, LEVEL, DRY
ACCELERATE TO 90 MPH IAS
MAXIMUM BRAKING EFFORT



WAIT FOR FUEL FLOW

When switching fuel tanks, be patient and wait for the flow from the newly selected tank. If you have already run a tank dry, this is a test of patience and your nervous system, but it's the only way to gain access to the fuel in the tank which contains it. Two accidents occurred in the last year because the pilot failed to wait for the fuel to flow from the full tank and returned the selector to the empty tank. That happened to a pilot in a 310 at Delta, UT, who compounded the problem by thinking that his tip tanks were the auxiliaries and the wing tanks were the mains. (The tip tanked Cessnas are an exception to the general proposition in small planes and our Comanches, that tip tanks, or in our case, auxiliary or outboard tanks, provide auxiliary fuel.) The 310 pilot only allowed 10 seconds for a restart before returning to the dry tank - and, of course, no restart there because there was no fuel.

The same problem occurred with a Bonanza pilot in the San Juan Islands in Washington. When he switched tanks after running one dry, he failed to wait for the lines to fill and provide fuel to the engine. He returned the selector to the dry tank, and, dead-sticked it onto the shoreline.

The first operational point should be: Don't run a tank dry, if you can avoid it. (Especially if not a max range flight. ed note)

The second point is: if you do, and you reasonably believe that your engine failure is due to fuel exhaustion, WAIT those excruciating seconds for the flow to start from your newly selected tank.

This requires an awful lot of mental stamina when it's so terribly quiet up there, but you can use the time to select your emergency landing field.

CARB ICING, LESSONS TO BE LEARNED

Jeffrey DeKanty, ICS #13311

In response to a request in the February issue of the Comanche Flyer, I thought I'd share my carburetor icing story. I learned from the experience, and perhaps others can too.

Two other owners of the late, great N5836P (A 1959 PA24-250 since totaled in an unfortunate but injury-free accident - I wasn't involved.) and I were en route from St. Petersburg / Clearwater Int'1 to Louisville, KY, on the first leg of our Oshkosh pilgrimage. I was at the controls; we were level at 8,000 feet. To the best of my knowledge, the outside air temperature was in the low 40's.

I was on an instrument clearance (even though the weather was "severe clear") and had just been handed off from one sector to another. My first indication of a problem (not the first the airplane gave me, but the first I noticed!) was the sudden onset of wild rpm variations, followed within seconds by the worst sound you can hear in an airplane... silence. At this point, I'm ashamed to say, I broke the oft' repeated rule of "don't drop the airplane to fly the microphone." My thumb was already on the transmit button when the gyrations began, and mentally, I was already primed to talk to center. Talk is what I did! Without even so much as the courtesy of an initial call-up, I called "Mayday." I identified myself, indicated we'd lost our engine and asked for vectors to the nearest airport. As the controller later told me, this got her attention in a hurry. I'll never know how close those precious seconds lost in that bonehead move brought us to disaster, but my friends on board remind me of it constantly. Fortunately my mind didn't go into total "idiot lock." I didn't wait for the response from center to start my engine-out checklist.

Fuel boost on, throttle, prop, mixture full forward, carb heat on, switch to a tank known to have fuel. In the time that it took for these actions to take effect, my second bonehead move was an entirely offbase assessment of the cause. 36Pop had a newly installed C412 threebladed prop and governor. The rpm variations led me to conclude that the governor was to blame. I know, it's embarrassing now, but that was my hastily-arrived-at conclusion. Fortunately, I didn't take any action based on this conclusion because, by this time, my training was starting to fight its way through the fog.

As an old story goes, a wizened veteran of the skies commented, when asked the first thing he does in an emergency... "look at the clock." I took a second to calm down and think through the airplane's response to my inputs. The engine was running again, but very roughly. I was turning to the heading that had somehow gotten from the controller's transmission into my racing brain and I had initiated a climb to exchange airspeed for altitude trying to target the right engine-out speed. I concluded that, at 8,000 feet, full rich was definitely not the right setting, so I leaned the engine and the situation returned to as near normal as could be expected.

Next, the three of us began attempting to isolate the cause (Nobody took seriously the notion of governor failure.) and thought that maybe I had run a tank dry. I wasn't scheduled for a tank change for another twenty minutes or so, limiting the likelihood of that being the cause. Still, I cautiously switched back to the tank I'd been using and discovered that wasn't the source of the problem. Then the idea of carb ice hit, and the bulb went on!

The airplane had tried to tell me there was a problem. For several minutes before things got quiet, I noticed a need for subtle nose-up trim inputs. In retrospect, there's no reason (other than the gradual onset of a power loss) for a plane in still, clear air to require nose-up trim after over two hours of steady cruise flight. That is the lesson I learned that I'd like to share.

If you're cruising along and everything's fine and you find yourself bumping up the trim to maintain altitude, the aircraft is trying to tell you something. The physics are simple; at an established power and attitude setting, the only reason you'd start to go down is if the power starts dropping. As the ice formed slowly in the carburetor, the power dropped and so too did the airplane. If I had thought that through, as I was trimming nose up and if I had kept the manifold pressure gauge in my scan to catch the drop, I could have saved myself a couple of quarts of adrenaline. Other lessons learned? A few I can share, including a few very personal ones.

First, I'll never be as cocky when reading other's tales of incidents. True, you read a lot of bonehead things, but don't judge your fellow pilots too harshly until you've been there. Until you've experienced that unsettling quiet, you don't know how you'll react. I am not in any way proud of my reaction to this situation, but I hope I've learned enough from this that the next time I experience carb icing (and there have since been other times) it won't cause quite the same degree of brain icing. (This, by the way, is where the reader is supposed to conclude that I'm being way too hard on myself!)

Also, I've learned to monitor the manifold pressure more closely, but only when I think the temperature outside is low enough. I more or less ignore it as long as the outside air temperature is somewhere over 500 degrees!

Finally, I've decided to modify my engine-out reaction. I was taught to work from one side of the panel to the other in an orderly way so as not to forget anything. This is useful and perhaps works in simpler aircraft. In a Comanche, or other high performance planes however, some actions taken out of order can mask the true problem. When I came across the mixture control in my orderly progression, I made the situation worse and hid the true nature of the problem by going to full rich at such a high altitude. From now on, I intend to follow that old pilot's advice and look at the clock first, gather my thoughts and take potentially corrective actions in an order that fits the situation at hand. The seconds lost won't mean as much as the beneficial impact of taking the right actions in the right order.

CARBURETOR ICING: THE REAL WORLD

Chuck Moore

I have heard that many people do not experience carburetor ice in their Comanche. Experience with my carburetored PA24-250 Comanche over the last 5 years (600+ hours) has been just the opposite: It is by far the worst to develop carburetor ice of the types I have regularly flown (3000 hours) - Taylorcraft BC12D / C152 / C172 / PA28-151 / Citabria 7ECA / PA24-250. I do not dispute those that say they have no problems with carburetor ice, rather, I think it must have something to do with a/c induction configuration.

My Comanche is a 1959 PA24-250 of S/N 1114 vintage. Ram air is directly inducted through a Bracket air filter into the carburetor air box and is ducted via a tightly fitted seal. Any time visible precipitation is present carburetor ice is a likelihood at temperatures above minus 25 Celsius to about plus 5 Celsius. This happens whether the engine is cold or fully warm, although it seems to be worse during climb when the engine is warming up. I utilize a carburetor temperature gauge to monitor the situation but it is not a foolproof device. Many times the gauge has shown in the "green" and I have had what appears to be severe carburetor ice situations. My all cylinder engine monitor is useful in detecting ice as well. I maintain constant vigilance when in these situations and experiment with the individual situation.

Carburetor ice is suspected if the manifold pressure drops 1 inch or more or if the carburetor temperature is in the "yellow" or "red" band and visible precip is present. I can tell you from experience that your heart will race at the roughness experienced from only a 2 inch drop in manifold pressure when full heat is applied. Worthy of note, is to be sure the engine is leaned for the altitude you are at because the roughness may be due to an overly rich engine when carburetor heat is applied.

I use one of two methods to combat carburetor ice. On detection of carburetor ice I first add full heat to clear the ice, then I add partial carburetor heat such that the carburetor temperature gauge reads approximately plus 10 Celsius and after a few minutes I add full heat and listen for a transient engine roughness. If no roughness is detected then I add partial heat at the level it was at at the start of the partial heat sequence. If roughness occurs then I add 5 more degrees and repeat the sequence until no roughness occurs. After the situation is stabilized, I lean the engine as per manufacturer's specs.

Method two is to modulate the carburetor heat from none to full on to none. This is done at an interval of time dependent on the severity of the carburetor ice situation and is experimentally derived. It is difficult to lean the engine properly while doing this, so I usually do not bother at altitudes less than 8K feet, unless, carburetor heat is applied more than 50% of the time. A typical cycle time for severe conditions can be as high as once per 2 minutes. There have been times when I needed full heat 100% of the time to keep the engine running. The most memorable time was while flying into a tropical storm IMC near Savannah, GA (11K ft/August) - this is a story in itself.

I once had a complete ram air induction system blockage that I think was caused by impact snow. I was IMC at an altitude of 8K ft over the mountains of Tennessee during the winter months and ran into an unforecasted cold front. The engine was already at 2500 rpm because the engine speed linkage is the first to freeze up in icing conditions. I applied full carburetor heat for about 2 minutes and as I removed heat the engine lost power and rpm immediately. I repeated the situation 2 or 3 time, and then just applied full heat and leaned while trying to climb as high as I could go - I made it to lOK feet before I was at 100 fpm. Later, when I could descend into warmer air, the condition cleared and the engine ran normally; however, I drank a lot of liquid to replace all the sweat generated during the ordeal.

ED: Moisture does NOT need to be Visible to produce ice.