A2A SIMULATIONS

C182

PREPAR3D®

ACCU-SIM C182 SKYLANE

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ACCU-SIM C182

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C182

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C182 SKYLANE


D-EXSW

CONTENTS

THE CESSNA 182

The Jack of All Trades and Master of All

THE MASTER OF ALL TRADES? WELL, PERHAPS THAT IS A BIT elaborate; however, the Cessna 182 is the proven master of a great many aeronautical "trades", indeed. So, what are the "trades" that we want a General Aviation (GA) aeroplane to be the master of? Well, we want it to be fast, carry lots of fuel, people and baggage, climb well, stall gently, be easy to land and fly, be economical to operate and maintain, and generally be a safe and pleasant ride for us and our passengers -- that's a lot to ask of one aeroplane. After all, the physical world is based upon compromise and give and take; what is gained here is lost there, etc. Because of this necessary compromise, when it comes to mastering all of these "trades", virtually every aeroplane fails to make the grade. Some exhibit very high performance but are a handful to fly for the average pilot and others are as gentle as a puppy, but do not perform so well. That ubiquitous physical compromise is present in most instances.

NOW CONSIDER THE CESSNA 182:

It has a light and simple fixed gear but it can cruise as fast, or nearly so, as many retractable gear aircraft. It can haul over 1,200 pounds of passengers, fuel and/or cargo. It will climb at nearly 1,000 fpm fully loaded and has an excellent ceiling and higher altitude performance even without turbocharging due to its generous supply of power. Due to very large and effective flaps, its slow speed and departed flight regimes are excellent, predictable and better in most circumstances than other aircraft in its class. Accordingly, a pilot may get it in and out of very small fields with confidence. Its engine is reliable, easily maintained and not unduly thirsty for fuel or oil. While it has a constant speed propeller, it is a simple and basic aeroplane to operate that may be quickly mastered by even relatively low-time pilots. It possesses a large and comfortable cabin for four plus a capacious baggage compartment. While it is maneouverable and quick on the controls, it is also stable around all axes and possesses no dangerous or surprising traits. It is an excellent IFR aeroplane. The C-182 and feels substantial and robust; it is well-made and can operate in and out of fairly rough airstrips. Its high wing allows unlimited downward visibility. Its rear cabin window gives a pilot increased visibility and grants a more spacious and open feeling to rear passengers.

The C-182T will cruise at 140KTAS at 10,000 while burning only 12 gallons an hour or so and this while carrying full fuel (88 U. S. gallons), four adults and some baggage and being a gentle and predictable aeroplane for the weekend pilot to confidently fly with his family. Since 2005 the Garmin G1000 Glass Cockpit has been available in the C-182. This makes instrument and low visibility flying easier and safer.

While practical and simple to operate, many consider the high-performance capability of Cessna 182 to be the ultimate aeroplane for the casual, sportsman flyer.

The Master of all trades? Well, almost all. It cannot break the sound barrier or reach 40,000. However, it is the master of so many trades that really matter, that no one could reasonably ask for more.

HOW?

By now you ought to have the feeling that there is very little that the C-182 cannot do - without ease, grace and élan. So, how did Cessna achieve this aeronautical superlative?

As any dog breeder will tell you, ancestry makes a great deal of difference. The C- 182's immediate ancestor is the Cessna 180, the 182 being essentially the tricycle gear version of the 180. In creating the C-180, the first thing Cessna did was to borrow what was an already proven wing design from the all metal

C-170/172. Below its high wing, however, the C-180/182 is an entirely new aeroplane.

The C-182's cowling is larger and fuselage is longer than the C-172's, and the cabin does not taper rearwards adding a good deal of useful space. The C-182's undercarriage is sturdier and more robust to handle its heavier weight. The C-182's six cylinder 230 h. p. engine is almost 60% more powerful than that of the C-172's but its gross weight is only 30% greater. This gives the C- 182 a very respectable power- loading of 13.52 lb./hp. While the C-172 and the C-182 share the same wing, that wing is more than large enough to give the C-182 a relatively light wing- loading of 17.8 lb./sq. ft. It is this combination of high power and low weight which produces the excellent performance that the C-182 demonstrates.

Greater power and a larger propeller produce more P-effect and torque which require appropriately sized tail surfaces to counter them. Accordingly, the C-182's tail surfaces (fin/rudder and stabilizer/elevators) were made larger to accommodate the additional power up front. While this results in a somewhat heavy feeling elevator whilst on the ground and at slow speeds, in the air the elevator is not disproportionately heavy as compared to other aircraft in its class.

Taking all of these design elements together, pound for pound the C-182 emerges as one of the most capable GA aircraft of all time, a true Master of All Trades. Superlative performance has been justly rewarded, with over 23.000 having been built, the C-182 is the second most popular and numerously produced high performance GA aeroplane of all time, just after the C-172.

WHY?

So, why did Cessna go to so much trouble to create an aeroplane with all of the ability that the C-182 possesses? As usual, there is more than one answer. One reason was due to market conditions. After the end of World War II, there was a fast growing demand for the so-called bush plane. The simplest definition of a bush plane is one which will be primarily operated in and out of rough, short and remote fields and waterways; those which could not in any real way be considered to be airports or airfields.

It has been long established that high -wing, tailwheel aeroplanes are best for bush flying. High wings sit well above the sometimes tall brush and far from stones and other debris which might be kicked up. The sturdy main gear of a tailwheel aeroplane is best suited for rough landings in fields which might actually damage a more delicate nosewheel strut. Also, a tailwheel aeroplane's propeller is higher off the ground when taking off, landing and taxiing than the propeller of a nosewheel aeroplane, putting it farther away from stones, etc.

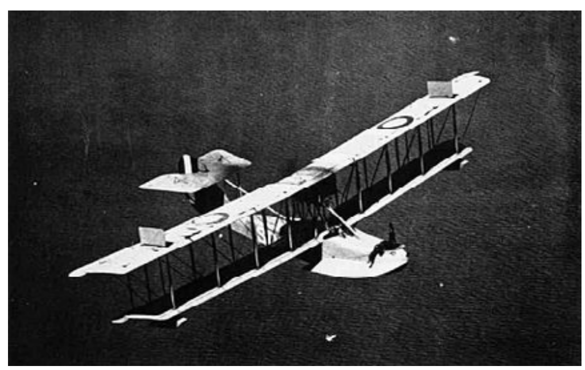
Cessna's high wing aeroplanes, with a sufficient amount of power and a tailwheel are ready-made for bush flying. The 170 had almost all of the features required for a bush aeroplane. What was wanted was a larger, more robust airframe and an increase in power. Thus came the C-180, which, with a nose wheel is the C-182.

BUSH LEAGUE

Contrary to popular belief, bush flying did not begin after W.W. II.; it began in Canada in 1919. Ellwood Wilson was a Canadian forester who was employed by the Laurentide Company located in Quebec. Laurentide trained foresters whom they hired out to large lumber companies. Of forester Wilson's many duties, surely very high in importance was the hopefully early detection and reportage of forest fires. One day Mr. Wilson had a brilliant idea: The forests were too vast for even hundreds of foresters like himself to properly patrol and map; however, from an aeroplane the entire forest could be well-patrolled and mapped and any sign of smoke that might indicate a burgeoning fire could be instantly detected and reported.

He obtained two surplus Curtiss HS-2L flying boats from the Canadian government. Between 4 and 8 June, 1919, the first aerial fire-patrol and photography missions were piloted by RCAS Captain Stuart Graham and engineer Walter Kahre. One of their cross-country flights of 645 miles to Lac-àla- Tortue, was at that time, the longest cross-country flight in Canada.

This and subsequent forest patrol flights of the Curtiss JS-2Ls are considered to be the very first bush aircraft operations. Laurentide Company initially financed these flights which received tremendous publicity in Canada. Soon thereafter a new subsidiary was formed, Laurentide Air Services, Ltd., the first exclusively bush operator in Eastern Canada.



Curtiss HS-2L in military use during W. W. I.

A Curtiss HS-2L of Laurentide Air Services in the early 1920s.

Curtiss JN-4 "Jenny"

An Airco DH-4 which was used in Air Mail service in the 1920's.

Piper J-3 "Grasshopper".

Very popular for bush flying is the Piper Super Cub with oversized tundra tires for rough fields.

Meanwhile, in Western Canada, in Edmonton, Wilfred May and his brother Court began the first commercial bush flying business in that area, called May Airplanes, Ltd. Flying a surplus Curtiss JN- 4 "Jenny" they, along with pilot George Gorman and mechanic Peter Derbyshire flew newspapers and small packages to outlying towns and villages.

Soon, these nascent companies were recognized to be successfully providing a vital service in the rugged and often isolated area of central Canada. In 1919, Carl Ben Eielson, an Alaskan originally from North Dakota, began flying passengers in a surplus "Jenny" from Fairbanks to and from outlying villages. In 1924 the U.S. Post Office granted Eielson a license to deliver mail in and around the Fairbanks area, but now in a far more powerful DH-4.

From these humble beginnings, bush flying in Canada, Alaska and the northern continental United States quickly blossomed into a major industry with thousands of aeroplanes connecting what were formerly remote and wild places with the rest of the world. Food, medicine, doctors and other vital commodities and people were, for the first time, now able to be delivered to so many remote regions which had been formerly bereft of these necessities.

After W. W. II, aircraft manufactures recognised that bush flying companies would be operating again without the restrictions upon civilian aviation that the war, out of necessity, had applied. It was not long before many of the Piper Cubs and Super Cubs, Stinsons, Aeroncas, all of the so -called "Grasshoppers" of the U. S. and Canadian Air Services began to show their age -- rough field and water flying taking its inevitable toll on them. New aircraft to replace these noble veterans were wanted.

THE CESSNA "AIRMASTER" - WHERE IT ALL BEGINS — FOR A WHILE

In 1935 Cessna introduced what was to be a very useful bush and cargo single-engine aeroplane- the C-145/165 'Airmaster". These were rugged, substantial aircraft made of wood and steel tubing with fabric covering. The wing was cantilever and did not require any external struts. Like virtually all aircraft of that era it had a tail wheel. It was ideal for rough country operations. With its capacious fuselage and an excellent useful load of 970 lbs. and later well over 1,100 lbs, with the 165 hp (123 kW) Warner engine installed. It was a very capable rough country aeroplane.

While Cessna's production of civilian Airmasters ended at the U. S. 's entry on to W.W. II on December 8, 1941, a few Airmasters, now called UC-77B, UC-77C, and UC-94 entered the into the military services of the U.S. A number of them were also used by the Air Forces of Australia and Finland.

The powerful and rugged 4-place, high wing Airmaster is the direct ancestor of all post- war Cessna single –engine aircraft.

Civilian 1938 Cessna C-165 "Airmaster"

Cessna C-37 Airmaster set up for bush operations with removed wheel pants and large tyres.

THE END OF THE WAR AND A NEW BEGINNING FOR CESSNA

In 1945, Cessna produced its only post-war radial-engined, five place aeroplane, the C-190/195. While Cessna had first designed and flown the 190 in 1945, it was not until 1947 that it was introduced it to the public. This is possibly because Cessna was hesitant to jump back into the post-war general aviation market with such an expensive aeroplane (which apparently did not at all daunt Beechcraft). Instead, the first Cessna introduced after the war was the modest, two-place, 65 hp C-120 which was available to the public in 1946.

The sole difference between a C-190 and a C-195 is its engine: the C-190 having a 240 h. p. Continental W670-23 radial engine, and a C-195 a 300 h. p. Jacobs R-755 radial engine. Both engines have a diameter of 42" which makes the 190/195's forward fuselage quite large and most capacious. With seating for five (two up front, three aft) the 195's useful load is 1,250 lbs. permitting full 75 gallon tanks plus four - 200 lb. or five - 160 lb. souls on board. Its published cruise is 170 mph (148 k; 274 km/h) at 70% power at 7, 500'. This was remarkable performance for a light aeroplane in 1947 and quite similar to the modern C-182.

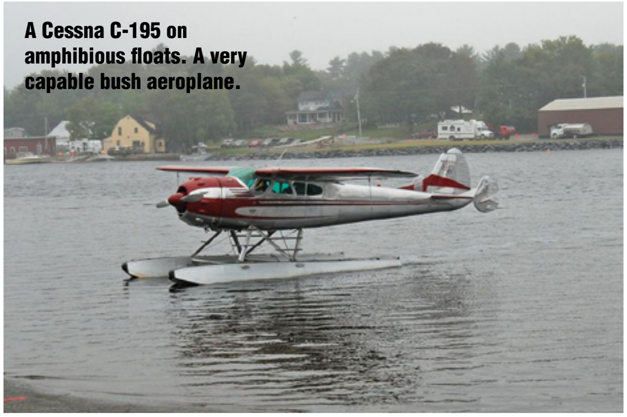
While the 190/195's wing is, as with the pre-war "Airmaster", a cantilever design, unlike the "Airmaster" the C-190/195 is of all- metal construction. Cessna apparently came to the understanding (as would Piper later in the decade) that manufacturing fabric-covered aeroplanes is highly labor intensive and therefore more costly to build than an all-metal aircraft. The C-190/195's airfoil is the familiar NACA 2412 as used by Cessnas' 170, 150, 172 and 182 to this day.

An expensive "luxury" type, the C-190/195 was not intended or expected to greatly fuel the post-war private General Aviation market. These large, 5-place aircraft were intended primarily to be used for commercial charter and business transportation rather than as a light aeroplane for personal use. Many of the 190/195s were converted to floatplanes which made them very useful commuter aircraft in areas where there were few or no airports. In this sense it could be said that the C-190/195 was a bush plane, although bush planes are generally not so well-appointed nor so elegant.

As impressive as its performance may be, the massive C-190/195 was too costly, its thirsty radial engine required a good deal of maintenance, and its general appearance, while sleek and attractive, was a definite throwback to aircraft of the thirties. Cessna understood that something new was wanted in the brave new era of peace.

SOMETHING NEW

Introduced in 1946, the basic and affordable 2-place Cessna 120 was an instant success. It spawned the C-140 which was then slightly stretched and in 1948 became the four-place 170. The 170 eventually



A Cessna C-195 on amphibious floats. A very capable bush aeroplane.

1949 Cessna 195. Sleek, powerful ...and expensive.

morphed into the all-metal, tricycle undercarriage Cessna 172 in 1956, which is where the modern era of Cessna aircraft begins.

The whole story of the how the C-172 came to be and how it evolved may be found in the A2A C-172 Manual and, accordingly, will not be repeated here. I do commend it to you, dear reader, even though I must admit that I wrote it. Nevertheless, you still may find it worthy of a glance or two, as therein is discussed the genesis and early development of the post- W.W. II Cessna line of light aircraft.

All went swimmingly well for a while, but Cessna became inundated by the pleas of those who loved the C-170 but wanted to go faster and carry more load. Some of those were bush pilots who operated in and out of the most primitive places on earth and who required aeroplanes with lots of power, load capacity, high performance and strength. Others simply wished to take their families on trips without having to land for fuel so often.

While the C-170 was an excellent, relatively inexpensive personal aeroplane for use in relatively civilized places, it did not have sufficient power, load carrying capability and overal performance necessary for serious bush flying (and it is all serious). As of 1952, except for the C-190/195, Cessna did not produce an aeroplane that could be inexpensively used as a bush plane.

Surely tired and frustrated at hearing how rival Piper Cubs and Super Cubs were hauling goods and people all around the remote northern regions, in 1952 Cessna decided to satisfy these clamouring requests and began to design the C-180.

THE CESSNA 180 – A RUGGED, HEAVY HAULER

The first thing that Cessna did in designing the 180 was to slightly increase the size of the fuselage to accommodate a new, more powerful engine, the 225 h. p. Continental O-470-A, O-470-J, and later a 230 h. p. Continental O-470-K engine. Some 180s have engines up to 300 h.p. The 180's larger fuselage also gave the cabin a bit more room, particularly in width, and tail surfaces were re-designed to accommodate the increase in power.

On 26 May, 1952, with Cessna's chief engineering test pilot William D. Thompson at the controls, the first Cessna 180, N41697, made its maiden flight. It was certified by the FAA's predecessor, the CAA (Civil Aeronautics Authority), on 23 December of that year; a nice Christmas present indeed for Cessna to give itself. During 1953, the C-180 was made available to the public. This was the "Golden Year" of aviation, in that it was 50 years since the Wright Brothers made what is considered to be the first powered flight; something Cessna did not fail to mention in its advertisements for the 180.

C-170 tail surfaces were originally round-shaped.

The more powerful C-180 tail surfaces are square- shaped and larger. This was later adopted for the C-170.

Even though the Cessna 180 has the same wing as the later model all-metal Cessna 170, the 180 is a very different aeroplane. It is heavier, more powerful and more capable in every way. Unlike the C-170, C-180 with its 1,100 lb. useful load can comfortably carry four adults and full fuel. Here is a basic comparison:

	Cessna 170	Cessna 180
Empty Weight	1,205 lbs.	1,700 lbs.
Useful Load	950 lbs.	1,100 lbs.
Power	145 h.p.	230 h.p.
Cruise	105 K	142 K
Stall (Full flaps at MGW)	43 K	48 K
Range (Statute miles)	590	1,024
Absolute Ceiling	15,500 ft.	17,700 ft.
Rate of Climb at MGW	590 fpm	1,100 fpm

Without question the Cessna 180 performed very well with its six- cylinder horizontally opposed 230 h. p. Continental engine. It was just what the bush pilots were looking for: an economical but hardy, heavy loader that could go long distances quickly without having to re-fuel. This was a much better deal than the larger C- 190/195, which was far more expensive to purchase, maintain and operate. It was even more capable and rugged than the excellent C-37 Airmaster.

FOLLOW THE MONEY

All of this was just fine; however, Cessna was not only in the business of selling aeroplanes to bush pilots, as commercially sound as that was. The really plush market in the burgeoning and prosperous middle 1950's was private pilots who wanted a fast aeroplane that could carry themselves and their families for long distances and not cost the Earth to do so. The C-170 was fine but its performance was, to be charitable, not spectacular.

However, the C-180 could do all that the C-170 could not. Cessna tried to sell the C-180 to private pilots but universally met with strong resistance over one matter in particular - the C-180 has a tail wheel. In the middle of the 1950's new aeroplanes had nosewheels.

More and more private pilots of that era were no longer content nor comfortable with an aeroplane with a tail wheel with its inherent instability on the ground, the high possibility of a groundloop at landing and the poor visibility over the nose when taxiing. Once a pilot had experienced flying an aeroplane with a nosewheel, he or she was not willing to go back to the tailwheel. Accordingly, Cessna had no good argument regarding this when pilots baulked at the C-180. The solution was more than obvious and Cessna, with yawning empty coffers anxiously awaiting to be filled with the loot to be gained by new purchases, went to work to remedy the deficiency.

IT LOOKS SO EASY, BUT...

Sometime during 1954, Cessna's Board of Directors were convinced that it would be in Cessna's best

Piper PA-22 Tri-Pacer. Note- fully steerable nosewheel

interest for the future to put nosewheels on their two top selling aeroplanes. They likely did not consider that this was going to be a big problem. After all, they were already manufacturing two very popular prime candidates for this modification, the C-170 and the newer C-180. It is likely that the Board had for some time resisted this rather expensive and extensive change until it was painfully pointed out to them that Cessna had indeed fallen far behind their competitors in this regard, particularly Piper with its prescient tricycle undercarriage Tri-Pacer which was introduced to the public in early 1951. Not having produced any single engine aircraft with a nosewheel by 1954 was certainly a major concern for Cessna. Ultimately convinced to go ahead, the Board directed Cessna's engineers to go to the drawing board and come up with a satisfactory solution. However, putting a nosewheel on an existing tailwheel aircraft is much easier said than done.

SO, WHAT'S THE BIG DEAL?

First, the main gear must be moved back behind the centre of gravity (C. G.) so that the aeroplane will firmly sit forward on its new nosewheel. This may sound at first blush to be a simple and obvious matter, but it is more of a problem than it might appear with respect to a high wing aeroplane such as the Cessna 180. One reason (of many) for the complication is because the main undercarriage is necessarily attached to the bottom of the C-180's fuselage and that fuselage has already been designed to absorb and transfer the stresses of taxiing and landing at the former, more forward attachment point of its main undercarriage legs. Low-wing, tailwheel aeroplanes which are re-designed for a nosewheel have many of the same problems as those of high-wing aeroplanes, however moving the main undercarriage attachment point farther aft on the wing is a simpler matter.

Of course, there are a few exceptions to the bottom of fuselage location for main undercarriage attachment on a high-wing, nosewheel aeroplane, particularly with regard to some twin engine, high-wing aeroplanes such as the Aero Commander, the Mitsubishi MU-2 and the Britten-Norman BN-2

LEFT: Aero Commander note- main undercarriage in engine nacelle

CENTER: Britten-Norman BN-2 Islander. Note- main undercarriage attached to engine nacelle

RIGHT: Grumman AA-5B "Tiger"- note simple non-steerable, castering nosewheel

Islander. In each of these examples, the main gear assembly is located in the engine nacelles. High-wing singles such as the C-180 do not have such a convenient place to attach the main gear as do those aeroplanes. Accordingly, the internal structure of the fuselage of the formerly "standard" undercarriage C-180 had perforce to be altered. It required that the new stress points, created by the relocated main gear, adequately transfer and distribute rough-field taxiing and landing forces into the fuselage structure; forces which in the real world are not always perfectly gentle and benign.

The exact placement rearward of the main gear must also be resolved. This is a complicated matter of balance and compromise that involves the consideration of a number of matters such as:

1. The location of the C. G. within a useable range after the nosewheel is installed. This must take into account the weight of the nosewheel assembly, since its position is well forward with respect to the aircraft datum or fuselage station. While the main undercarriage sits slightly behind the C.G. and having two wheels and legs, etc. is heavier, it does not necessarily offset the forward moment arm of the new nosewheel assembly.
2. The balance of the aeroplane when on the ground. The main undercarriage legs must be placed far enough aft to provide a stable platform for the aeroplane to sit upon. It must also be far enough aft to prevent the aeroplane from tending to easily tip back onto its tailskid under normal operating, load and wind conditions; however…
3. The main undercarriage legs must not be so far aft so as to prevent rotation or create too high a load for the elevator to lift the nose on takeoff. A certain aft placement of the main undercarriage legs might make for a very stable aeroplane whilst on the ground, but if it is placed too far aft the resulting geometry may cause a situation in which the elevator may not be powerful enough to lift the nose during the takeoff.

Other considerations include:

1. The nosewheel assembly's added mass and drag below the data line which will likely cause pitch – down.
2. The additional weight of the nosewheel which reduces the aeroplane's useful load.
3. The new tri-cycle geometry must allow for precise and positive braking, taxiing.
4. The placement of the main undercarriage legs must not prevent and ought to aid entry into the aeroplane.
5. The transfer of forces during taxiing and landing must not unduly disturb the pilot and passengers.

There are probably a few more considerations as well, but I presume that the point has been made.

Once these many thorny problems are resolved to the best of the design engineers' ability, the matter of the nose wheel assembly itself and its placement must be addressed. The area beneath the engine and its accessories where there was little to no space must now house the nosewheel assembly attachment. This includes a strut of sufficient strength and robustness to withstand rough field taxiing and less than gentle landings. Not only that, but the nosewheel's steering mechanism and its linkages must also be considered. In some nosewheel aircraft such as the Grumman AA-5A "Cheetah" and the AA-5B "Tiger", the Tecnam P Twenty-Ten and many homebuilt aircraft, this particular problem at least has been simplified by installing a free- castering nosewheel whereby all ground steering is achieved by differential braking and not by a direct link to the nosewheel. Additionally, free-castering nosewheel permits a very tight turning circle and many pilots report that they like it better than a steerable nosewheel. Cessna desired to provide a fully steering nosewheel as did Piper's Tri-Pacer and many other aircraft, so the complex linkages from the rudder pedals to the nosewheel had to be designed and space for all of this had to be found.

The very first Cessna 182 (N4966E)

ABOVE RIGHT: 1956 C-182 panel with a few radios, etc. added.

BELOW RIGHT: 1956 C-182. Even with a nosewheel flip- overs are possible.

PRESENTING: (APPROPRIATE FANFARE) THE CESSNA 182

In November 1955 the C-172 was introduced to the public, albeit as a 1956 model. Within a few months, in early 1956, the C-182 took its opening bow. It was an instant success in the GA market. The following year the C-182 was upgraded and became the "Skylane". Bush pilots, however, continued and continue to date to operate C-180s as even the best nose wheel system is considered to be too delicate for operations in rough country. With over 23,000 C-182/Skylanes having been produced to date the C-182/Skylane has certainly proven to be a popular ride.

IT KEEPS GETTING BETTER, BUT THE 'PLANE REMAINS THE SAME

The C-182/Skylane did not sit dormant for very long before improvements and modifications were incorporated by Cessna. Engines, landing gear material, larger windows, and cabin appointments have changed and its useful load has steadily increased. However, even with all of these changes, the Cessna 182 remains the same simple, fast, heavy hauling, comfortable, easy to fly aeroplane that it was when it was first introduced in November, 1955.

Sure, over the years there have been a few modifications to the airframe, the vertical fin and rudder being swept back with "D" model in 1960, and the most dramatic and obvious change being the cut down rear fuselage and the installation of "Omni-Vision" (a rear cabin window) with "E" model in 1961. In 1996, with the "S" model, the familiar Continental O-470-U engine was replaced by the fuel injected Lycoming IO-540 of similar power. Other than that the 182's changes have been modest and subtle, updated radios, fancier cabin appointments and such.

The retractable gear R182 was introduced in 1977, and a turbocharged T182 was introduced in 1980. Both retractable gear and a turbocharged engine were available in the TR182 in 1978. In 2001, a turbocharged and fuel injected engine was available in the T182T. The introduction of the Garmin G1000 "Glass Cockpit" was introduced as standard equipment in 2004. A diesel engined 182, the T182JT-A, was tested in 2012 and set for delivery to its first customer this year.

THE C-182T

With each new model the Cessna 182 shows thoughtful improvements which enhance its usefulness and convenience, sometimes in large gulps, sometime in smaller ones. The "T" model 182 is no exception and displays a number of changes from the previous "S" model.

Aside from the optional Garmin G1000 "Glass Cockpit" (not modelled) there are other electronic enhancements. Recognizing that the electrical system of the 182 had become more sophisticated as well as more capacious. The avionics master switch now controls a split electrical bus. Also, there is an additional main bus with a standby battery position. For safety in the event that there should occur an electrical system malfunction the avionics are divided onto two discrete, separately switchable busses. Should a particular component or group of components malfunction and it becomes necessary to shed electrical load on the main system, basic navigation and/or communication capability may be preserved by shutting down power to Nav I or II and/or Com I or II while leaving the other radios operational. Bus #1 switches the Honeywell Bendix/King KLN 94, if so equipped, plus the #1 Nav/Com. Bus #2 switches the Bendix/King KMD 550 multifunction display (MFD), if so equipped, the #2 Nav/Com and the transponder.

The "T" model continues Cessna's safe and wise practice of dividing the most important instruments between electric and hydraulic power, so that if one system should fail, at least half of the instruments would still operate.The Directional Gyro (or HSI if one is installed) is powered by the electrical system while the Attitude Indicator (Artificial Horizon) is driven by the vacuum system. There are two constantly working vacuum pumps in C-182T's with Nav I and Nav II equipment and one vacuum pump in Nav III 182s.

Cosmetically the 182"T" continues the practice of painting on the trim over the white base colour. Previously, and prior to 2003 the trim stripes were decals which were clear coated to preserve them from the weather, etc. Not surprisingly, this did not work out so well in all instances and more than a few decal-trimmed 182Ts are showing a bit of ragged wear. Since 2003 the 182 has painted on trim.

The 182T's seats are available covered in either fabric or leather, at no cost difference (A2A opted for the leather). The control yokes are leather bound for better traction when hauling back that heavy elevator. The LED interior lighting makes after dark flying a pleasure. Unlike former 182's painted spinners the "T" model's spinner is a spiffy polished aluminium.

The "T" model also underwent a thorough aerodynamic drag reduction program that added four knots over the "S" model under the same power:

1. **Sleeker** undercarriage leg and wheel-pants fairing.
2. Improved wingtips with internally mounted navigation lights.
3. Improved cowling promoting more efficient air movement within.
4. Draggy wire antennae on the vertical fin replaced with flat plate antennae aligned with the airflow.
5. Sleeker cockpit entry steps on the main undercarriage legs.

Also, the 230-horsepower Lycoming IO-540 has been de-rated to operate at 2,400 rpm max. which will surely tend to increase the practical TBO (time between overhaul) and reduce maintenance costs. The "S" model's three-blade McCauley prop with curved leading and trailing edges is standard equipment on the "T".

Over the years pilot ergonomics has not been ignored by Cessna. In the 182's cockpit everything is where you might expect it to be and all controls, switches and buttons fall nicely to hand. Flap, gear and trim controls feel like what they control, and operate intuitively. However, the optional electric elevator trim button on the pilot's control yoke is highly recommended being that the 182's high wing and generous quotient of power on a thrust line some distance below it makes this aeroplane want trim and plenty of it upon every change of power and/or airspeed. While the C-182T has a 24 volt electrical system, in keeping up with the times for the pilot's and passengers' convenience, for the first time there is now a 12 volt outlet plug for an outboard electrical device such as a GPS, laptop, IPad, or whatever.

PERFORMANCE COMPARISON

	Cessna 182S SKYLANE	Cessna 182T SKYLANE	PIPER 235 DAKOTA
Engine	Lycoming IO-540-AB1A5	Lycoming IO-540-AB1A5	Lycoming O-540-J3A5D
Horsepower	230	230	235
Top Speed	146 KTS.	150 KTS.	148 KTS.
Cruise speed	142 KTS.	145 KTS.	143 KTS.
Stall Speed (full flaps)	49 KTS.	49 KTS.	56 KTS.
Takeoff			
Ground Roll	805 ft.	795 ft.	795 ft.
Over 50 ft obstacle	1,515 ft.	1,514 ft.	1,216 ft.
Rate Of Climb	865 fpm	924 fpm	1,010 fpm.
Ceiling	14,900 ft.	18,100 ft.	18,100 ft.
Gross Weight	3,100 lbs.	3,100 lbs.	3,000 lbs.
Empty Weight	1,775 lbs.	1,897 lbs.	1,608 lbs.
Useful load		1,213 lbs.	1,382 lbs.
Fuel Capacity	92 gal.	88 gal.	72 gal.
Range	817 nm.	968 nm.	650 nm.
Landing			
Ground Roll	590 ft.	590 ft.	825 ft.
Over 50 ft obstacle	1,350 ft.	1,350 ft.	1,725 ft.

LIKE AN OLD, COMFORTABLE PAIR OF SHOES

From its inception the Cessna 182 filled a need in the GA industry that it still fills, and with distinction. Steadily evolving since its introduction 1955 it has never strayed far from its original incarnation. If a pilot who flew the very first C-182 were to fly the latest model, he or she would still find the cockpit to be a familiar environment; and with the exception, perhaps, of the flap control, originally manual and now electric, everything would still essentially be where it always had been and operate as it always did. He or she would find it just as satisfying to fly as it always has been, like putting on an old, comfortable pair of shoes; and that quality, in the end, may be the Cessna 182's greatest achievement.

The Cessna 182 flies and operates like a basic, simple aeroplane that any low-time Private Pilot could easily check out in within an hour or two at most, while it constantly delivers the high performance of a more complex and demanding aeroplane. No doubt, as time passes, continuing improvements will be made to the venerable Cessna 182 that will surely enhance it in many ways. But the basic aeroplane, that master of virtually all aeronautic trades, will remain a familiar old friend and perhaps the greatest of all GA aeroplanes.

DESIGNER'S NOTES

THE 182 TO ME, MEANS BUSINESS. It's large, comfortable, and tough.

Upon first entering the cabin, you are greeted with an expansive, wide, and especially long interior. My initial thought was, "wow, four people would be very comfortable in here, even for long cross country flights." The rear baggage is also easily accessible just behind the rear seat, making the entire lengthy interior accessible in flight.

If you are familiar with it's smaller brother, the Skyhawk, your eyes should catch some additional gauges including a CHT (cylinder head temp), a large fuel gallons per hour gauge, manifold pressure, a blue prop handle, a cowl flaps lever, and rudder trim. And in general, the panel is wider and more expansive.

If you are like me, when you first step into a cockpit, you will grab the yoke or stick to get a feel for the controls and linkage. When I first pulled back on the yoke in the Skylane, I thought "who put sand bags on the elevator?" It's that heavy, and by my own measurements, a Skyhawk requires 6 lbs to lift the elevator while the Skylane requires a whopping 25lbs. Having spoken with several 182 owners and pilots, this heavy elevator is a "love – hate" relationship, with most loving it.

Starting the powerful Lycoming 540 engine, you are greeted by a throaty exhaust note. This plane sounds mean. However, when you start to taxi, it reminds me of an old 1970's American car power steering. While the rudders feel just as light as a feather, you're aware that these delicate forces are moving a large and powerful vehicle.

At takeoff, a 3-bladed prop has a distinctly strong pull off the line and reaches 60 mph almost twice as fast as the Skyhawk or Cherokee. As soon as you lift off into a climb, you will see climb rates between 1,000-2,000 ft / min. And being a high performance airplane, after takeoff you will want to pull the throttle back to 23" of manifold pressure, which is about 2/3rds throttle. As you climb higher into thinner air, you can slowly increase the throttle to maintain 23". If you are planning for a higher altitude cruise, you are in for a treat because with it's high lift wing, drooping wing tips, and 541 cu engine, it will continue to climb strong right to your desired height.

Once you settle, and begin trimming for cruise, you will see a nice increase of 15-20 KTS over the smaller GA planes and the entire time you will also enjoy a smoother ride from the higher wing loading.

Being a high wing airplane with power, any significant power or speed changes will require a strong pull or push on the yoke until you adjust trim. This can get especially heavy on final, if you don't dial in enough nose up trim. To quote Dudley Henriques, "If someone told me they just bought a 182, my first question would be "does it have electric trim?" if not, I would recommend they stop what they are doing and get one installed immediately."

When you start to slow down for your approach, you need to be mindful of the trim at all times. Because if you don't have enough trim dialed in as you cross the threshold, you may not be able to flare this properly. This is not an airplane you fly with a thumb and finger; you fly and especially land a Skylane with a tightly clenched fist and a strong fore arm.

However, once in the flare (assuming you have it properly trimmed), the heavy elevator really counters any instinct to over flare. I find the Skylane to be one of the easiest planes to land (again, if properly trimmed) as the wing continues to fly well even at high angles of attack. If you don't have it trimmed properly, however, you will be in for a hard touchdown.

When you do finally touch down, the feel of the wheels digging into the pavement tells you just how tough this bird's landing gear is. Even if you did land it very hard, the feeling is this plane could take a lot more. The large tires dig into the pavement, and the gear flexes beautifully. This is no doubt a plane originally designed for some very tough terrain.

Once you have slowed down and exit the runway, the feather light taxi forces feel as if someone laid a red carpet out for you after your flight. It's just the easiest, most pleasurable airplane to taxi. I cannot imagine improving on this aspect.

No question, the Cessna 182 Skylane is an airplane that can do everything you ask it too, and I can see how owners can become quite attached and loyal to their Skylane. It's also no surprise why the Skylane is the world's most produced high performance general aviation airplane of all time. I hope you enjoy your Accu-Sim Skylane, as we have certainly enjoyed making (and flying) it.

A2A simulations

THE AIR TO AIR SIMULATIONS TEAM

FEATURES

- A true propeller simulation.
- Interactive pre-flight inspection system.
- Gorgeously constructed aircraft, inside and out, down to the last rivet.
- Physics-driven sound environment.
- Complete maintenance hangar internal systems and detailed engine tests including compression checks.
- Visual Real-Time Load Manager.
- Piston combustion engine modeling.Air comes in, it mixes with fuel and ignites, parts move, heat up, and all work in harmony to produce the wonderful sound of a Lycoming 540 engine. Now the gauges look beneath the skin of your aircraft and show you what Accu-Sim is all about.
- Authentic Bendix King Avionics stack including the KMA 26 Audio Panel, two KX 155A NAV/COMMS, KR 87 ADF, KT 76C Transponder, KN 62A DME, and KAP 140 Two Axis Autopilot with altitude pre-selection. Optional KI 525 HSI.
- Three in-sim avionics configurations including no GPS, GPS 295, or the GNS 400. Built-in, automatic support for 3rd party GNS 430 and 530, GTN 650 and 750.
- Electric starter with accurate cranking power.
- Dynamic ground physics including both hard pavement and soft grass modeling.
- Primer-only starts.
- Persistent airplane even when the computer is off.
- Four naturally animated passengers that can sit in any seat.
- 3D Lights ‘M’ (built directly into the model).
- Pure3D Instrumentation.
- In cockpit pilot’s map.
- Authentic fuel delivery includes priming and proper mixture behavior. Mixture can be tuned by the book using the EGT or by ear. It’s your choice.
- A2A specialized materials with authentic metals, plastics, and rubber.
- Oil pressure system is affected by oil viscosity (oil thickness). Oil viscosity is affected by oil temperature. Now when you start the engine, you need to be careful to give the engine time to warm.
- Eight commercial aviation sponsors have supported the project including Phillips 66 Aviation, Champion Aerospace, and Knots2u speed modifications.
- And much more …

QUICK START GUIDE

CHANCES ARE, IF YOU ARE reading this manual, you have properly installed the A2A Accu-Sim C182 Skylane. However, in the interest of customer support, here is a brief description of the setup process, system requirements, and a quick start guide to get you up quickly and efficiently in your new aircraft.

SYSTEM REQUIREMENTS

The A2A Simulations Accu-Sim C182 Skylane requires the following to run:

- Requires licensed copy of **Lockheed Martin Prepar3D**

OPERATING SYSTEM:

- Windows XP SP2
- Windows Vista
- Windows 7

PROCESSOR:

2.0 GHz single core processor (3.0GHz and/or multiple core processor or better recommended)

HARD DRIVE:

250MB of hard drive space or better

VIDEO CARD:

DirectX 9 compliant video card with at least 128 MB video ram (512 MB or more recommended)

OTHER:

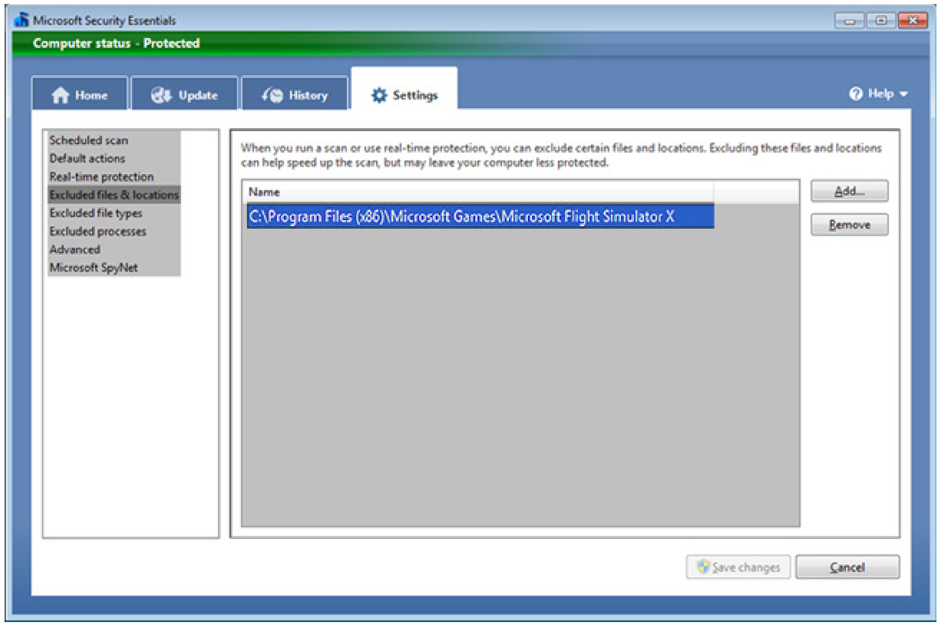
DirectX 9 hardware compatibility and audio card with speakers and/or headphones

INSTALLATION

Included in your downloaded zipped (.zip) file, which you should have been given a link to download after purchase, is an executable (.exe) file which, when accessed, contains the automatic installer for the software.

To install, double click on the executable and follow the steps provided in the installer software. Once complete, you will be prompted that installation is finished.

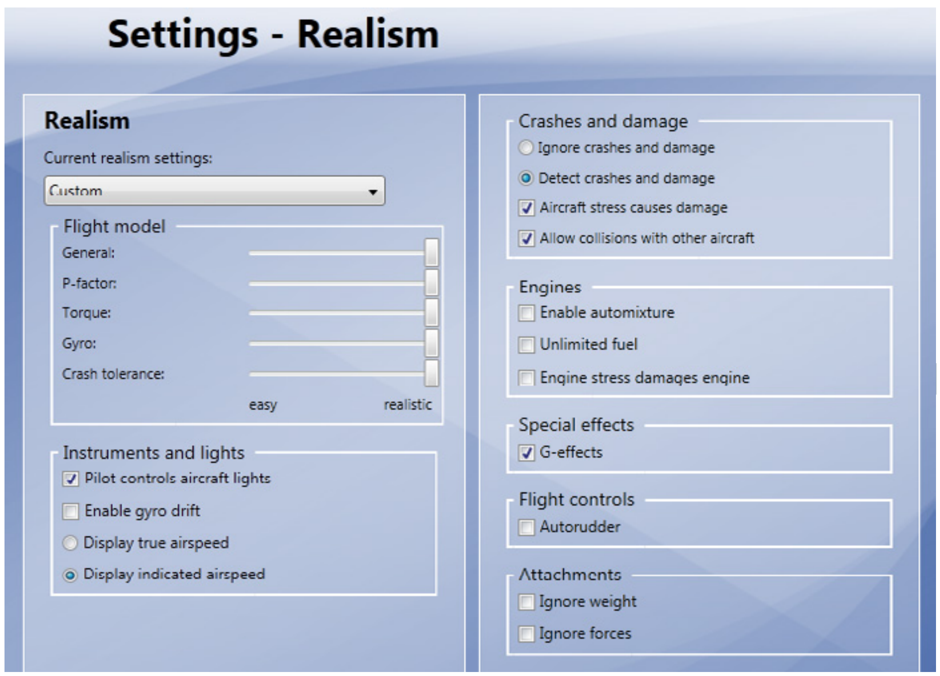
IMPORTANT: If you have Microsoft Security Essentials installed, be sure to make an exception for Lockheed Martin Prepar3D as shown right.



REALISM SETTINGS

The A2A Simulations Accu-Sim C182 Skylane was built to a very high degree of realism and accuracy. Because of this, it was developed using the highest realism settings available in Lockheed Martin Prepar3D.

The following settings are recommended to provide the most accurate depiction of the flight model. Without these settings, certain features may not work correctly and the flight model will not perform accurately. The figure below depicts the recommended realism settings for the A2A Accu-Sim C182 Skylane.



FLIGHT MODEL

To achieve the highest degree of realism, move all sliders to the right. The model was developed in this manner, thus we cannot attest to the accuracy of the model if these sliders are not set as shown above. The only exception would be "Crash tolerance."

INSTRUMENTS AND LIGHTS

Enable "Pilot controls aircraft lights" as the name implies for proper control of lighting. Check "Enable gyro drift" to provide realistic inaccuracies which occur in gyro compasses over time.

"Display indicated airspeed" should be checked to provide a more realistic simulation of the airspeed instruments.

ENGINES

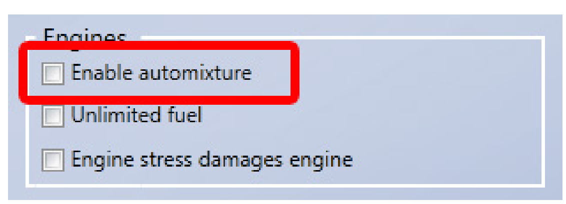
Ensure "Enable auto mixture" is NOT checked. The C182 has a fully working mixture control and this will interfere with our extensively documented and modeled mixture system.

FLIGHT CONTROLS

It is recommended you have "Auto-rudder" turned off if you have a means of controlling the rudder input, either via side swivel/twist on your specific joystick or rudder pedals.

ENGINE STRESS DAMAGES ENGINE

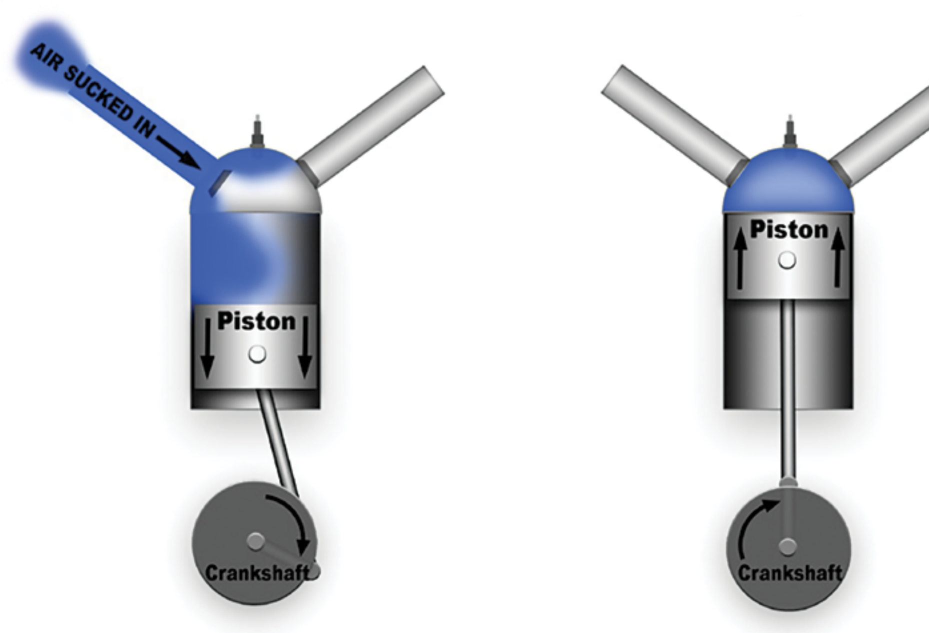
(Acceleration Only). It is recommended you have this **UNCHECKED**.



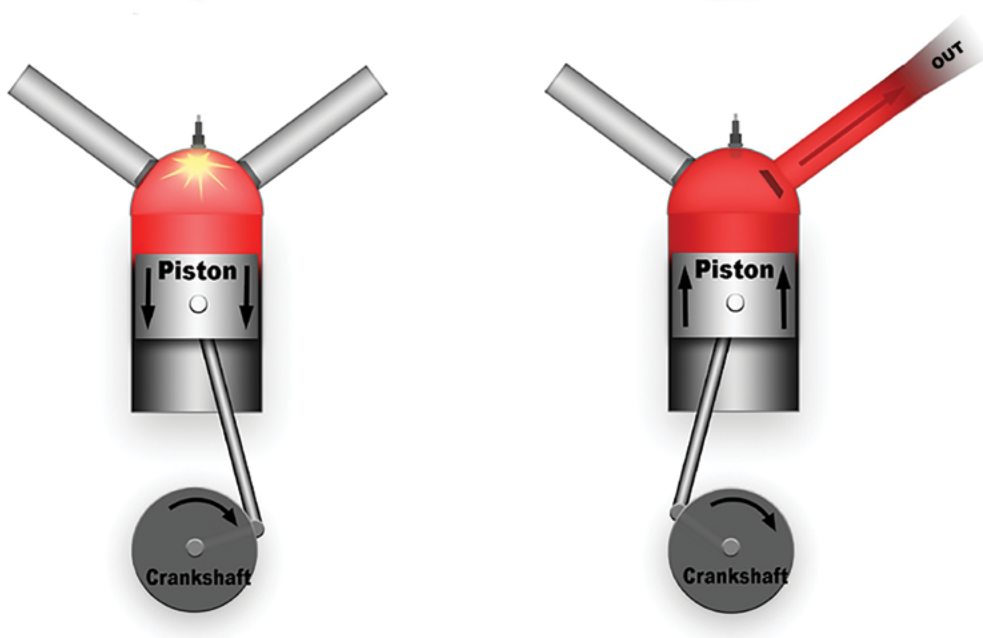
QUICK FLYING TIPS

- ✪ To Change Views Press A or SHIFT + A.
- ✪ Keep the engine at or above 800 RPM. Failure to do so may cause spark plug fouling. If your plugs do foul (the engine will sound rough), try running the engine at a higher RPM. You have a good chance of blowing them clear within a few seconds by doing so. If that doesn't work, you may have to shut down and visit the maintenance hangar.
- ✪ Reduce power after takeoff. This is standard procedure with high performance aircraft.
- ✪ On landing, raise your flaps once you touch down to settle the aircraft, pull back on the stick for additional elevator braking while you use your wheel brakes.
- ✪ Be careful with high-speed dives, as you can lose control of your aircraft if you exceed the max allowable speed.
- ✪ For landings, take the time to line up and plan your approach. Keep your eye on the speed at all times.
- ✪ Using in-sim accelerated time may cause odd system behavior.
- ✪ Keep throttle above ⅓ when flying at high RPM to avoid fouling plugs.
- ✪ A quick way to warm your engines is to use auto start (*CTRL-E*) or re-load your aircraft while running.

ACCU-SIM AND THE COMBUSTION ENGINE



The piston pulls in the fuel / air mixture, then compresses the mixture on its way back up.



The spark plug ignites the compressed air / fuel mixture, driving the piston down (power), then on it's way back up, the burned mixture is forced out the exhaust.

THE COMBUSTION ENGINE IS BASICALLY AN AIR PUMP. IT CREATES power by pulling in an air / fuel mixture, igniting it, and turning the explosion into usable power. The explosion pushes a piston down that turns a crankshaft. As the pistons run up and down with controlled explosions, the crankshaft spins. For an automobile, the spinning crankshaft is connected to a transmission (with gears) that is connected to a driveshaft, which is then connected to the wheels. This is literally "putting power to the pavement." For an aircraft, the crankshaft is connected to a propeller shaft and the power comes when that spinning propeller takes a bite of the air and pulls the aircraft forward.

The main difference between an engine designed for an automobile and one designed for an aircraft is the aircraft engine will have to produce power up high where the air is thin. To function better in that high, thin air, a supercharger can be installed to push more air into the engine.

OVERVIEW OF HOW THE ENGINE WORKS AND CREATES POWER

Fire needs air. We need air. Engines need air. Engines are just like us as – they need oxygen to work. Why? Because fire needs oxygen to burn. If you cover a fire, it goes out because you starved it of oxygen. If you have ever used a wood stove or fireplace, you know when you open the vent to allow more air to come in, the fire will burn more. The same principle applies to an engine. Think of an engine like a fire that will burn as hot and fast as you let it.

Look at these four images on the left and you will understand basically how an engine operates.

The piston pulls in the fuel / air mixture, then compresses the mixture on its way back up.

The spark plug ignites the compressed air / fuel mixture, driving the piston down (power), then on it's way back up, the burned mixture is forced out the exhaust.

AIR TEMPERATURE

Have you ever noticed that your car engine runs smoother and stronger in the cold weather? This is because cold air is denser than hot air and has more oxygen. Hotter air means less power.

Cold air is denser and so provides more oxygen to your engine. More oxygen means more power.

MIXTURE

Just before the air enters the combustion chamber it is mixed with fuel. Think of it as an air / fuel mist.

A general rule is a 0.08% fuel to air ratio will produce the most power. 0.08% is less than 1%, meaning for every 100 parts of air, there is just less than 1 part fuel. The best economical mixture is 0.0625%.

Why not just use the most economical mixture all the time?

Because a leaner mixture means a hotter running engine. Fuel actually acts as an engine coolant, so the richer the mixture, the cooler the engine will run.

However, since the engine at high power will be nearing its maximum acceptable temperature, you would use your best power mixture (0.08%) when you need power (takeoff, climbing), and your best economy mixture (.0625%) when throttled back in a cruise when engine temperatures are low.

So, think of it this way:

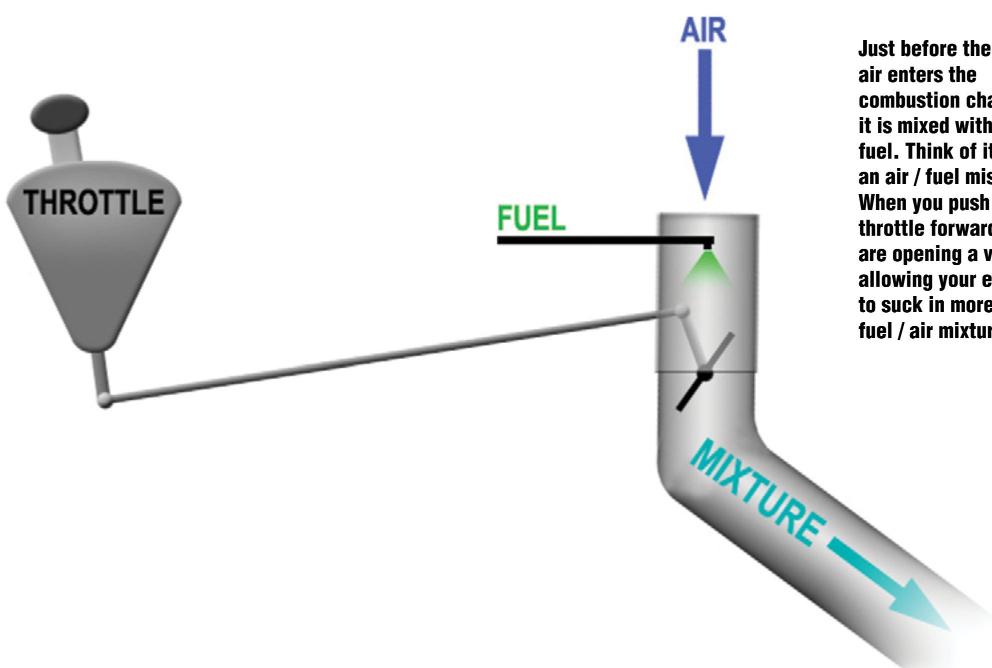
- ▶ For **HIGH POWER**, use a **RICHER** mixture.
- ▶ For **LOW POWER**, use a **LEANER** mixture.

THE MIXTURE LEVER

Most piston aircraft have a mixture lever in the cockpit that the pilot can operate. The higher you fly, the thinner the air, and the less fuel you need to achieve the same mixture. So, in general, as you climb you will be gradually pulling that mixture lever backwards, leaning it out as you go to the higher, thinner air.

How do you know when you have the right mixture?

The standard technique to achieve the proper mixture in flight is to lean the mixture until you just notice the engine getting a bit weaker, then richen the mixture until the engine sounds smooth. It is this threshold that you are dialing into your 0.08%, best power mixture. Be aware, if you pull the mixture all the way back to the leanest position, this is mixture cutoff, which will stop the engine.



Just before the air enters the combustion chamber it is mixed with fuel. Think of it as an air / fuel mist. When you push the throttle forward, you are opening a valve allowing your engine to suck in more fuel / air mixture.

INDUCTION

As you now know, an engine is an air pump that runs based on timed explosions. Just like a forest fire, it would run out of control unless it is limited. When you push the throttle forward, you are opening a valve allowing your engine to suck in more fuel / air mixture. When at full throttle, your engine is pulling in as much air as your intake system will allow. It is not unlike a watering hose – you crimp the hose and restrict the water. Think of full power as you just opening that water valve and letting the water run free. This is 100% full power.

In general, we don't run an airplane engine at full power for extended periods of time. Full power is only used when it is absolutely necessary, sometimes on takeoff, and otherwise in an emergency situation that requires it. For the most part, you will be 'throttling' your motor, meaning you will be be setting the limit.

MANIFOLD PRESSURE = AIR PRESSURE

You have probably watched the weather on television and seen a large letter L showing where big storms are located. L stands for **LOW BAROMETRIC PRESSURE** (low air pressure). You've seen the H as well, which stands for **HIGH BAROMETRIC PRESSURE** (high air pressure). While air pressure changes all over the world based on weather conditions, these air pressure changes are minor compared to the difference in air pressure with altitude. The higher the altitude, the much lower the air pressure.

On a standard day (59°F), the air pressure at sea level is 29.92 in. Hg **BAROMETRIC PRESSURE**. To keep things simple, let's say 30 in. Hg is standard air pressure. You have just taken off and begin to climb. As you reach higher altitudes, you notice your rate of climb slowly getting lower. This is because the higher you fly, the thinner the air is, and the less power your engine can produce. You should also notice your **MANIFOLD PRESSURE** decreases as you climb as well.

Why does your manifold pressure decrease as you climb?

Because manifold pressure is air pressure, only it's measured inside your engine's intake manifold. Since your engine needs air to breath, manifold pressure is a good indicator of how much power your engine can produce.

Now, if you start the engine and idle, why does the manifold pressure go way down?

When your engine idles, it is being choked of air. It is given just enough air to sustain itself without stalling. If you could look down your carburetor throat when an engine is idling, those throttle plates would look like they were closed. However if you looked at it really closely, you would notice a little space on the edge of the throttle valve. Through that little crack, air is streaming in. If you turned your ear toward it, you could probably even hear a loud sucking sound. That is how much that engine is trying to breath. Those throttle valves are located at the base of your carburetor, and your carburetor is bolted on top of your intake manifold. Just below those throttle valves and inside your intake manifold, the air is in a near vacuum. This is where your manifold pressure gauge's sensor is, and when you are idling, that sensor is reading that very low air pressure in that near vacuum.

As you increase power, you will notice your manifold pressure comes up. This is simply because you have used your throttle to open those throttle plates more, and the engine is able to get the air it wants. If you apply full power on a normal engine, that pressure will ultimately reach about the same pressure as the outside, which really just means the air is now equalized as your engine's intake system is running wide open. So if you turned your engine off, your manifold pressure would rise to the outside pressure. So on a standard day at sea level, your manifold pressure with the engine off will be 30".

IGNITION

The ignition system provides timed sparks to trigger timed explosions. For safety, aircraft are usually equipped with two completely independent ignition systems. In the event one fails, the other will continue to provide sparks and the engine will continue to run. This means each cylinder will have two spark plugs installed.

An added advantage to having two sparks instead of one is more sparks means a little more power. The pilot can select Ignition 1, Ignition 2, or BOTH by using the MAG switch. You can test that each ignition is working on the ground by selecting each one and watching your engine RPM. There will be a slight drop when you go from **BOTH** to just one ignition system. This is normal, provided the drop is within your pilot's manual limitation.

The air and fuel are compress by the piston, then the ignition system adds the spark to create a controlled explosion.

ENGINE TEMPERATURE

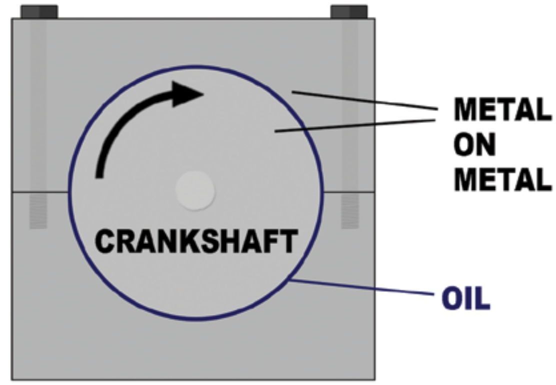
All sorts of things create heat in an engine, like friction, air temp, etc., but nothing produces heat like **COMBUSTION.** The hotter the metal, the weaker its strength.

Aircraft engines are made of aluminum alloy, due to its strong but lightweight properties. Aluminum maintains most of its strength up to about 150°C. As the temperature approaches 200°C, the strength starts to drop. An aluminum rod at 0°C is about 5× stronger than the same rod at 250°C, so an engine is most prone to fail when it is running hot. Keep your engine temperatures down to keep a healthy running engine.

LUBRICATION SYSTEM (OIL)

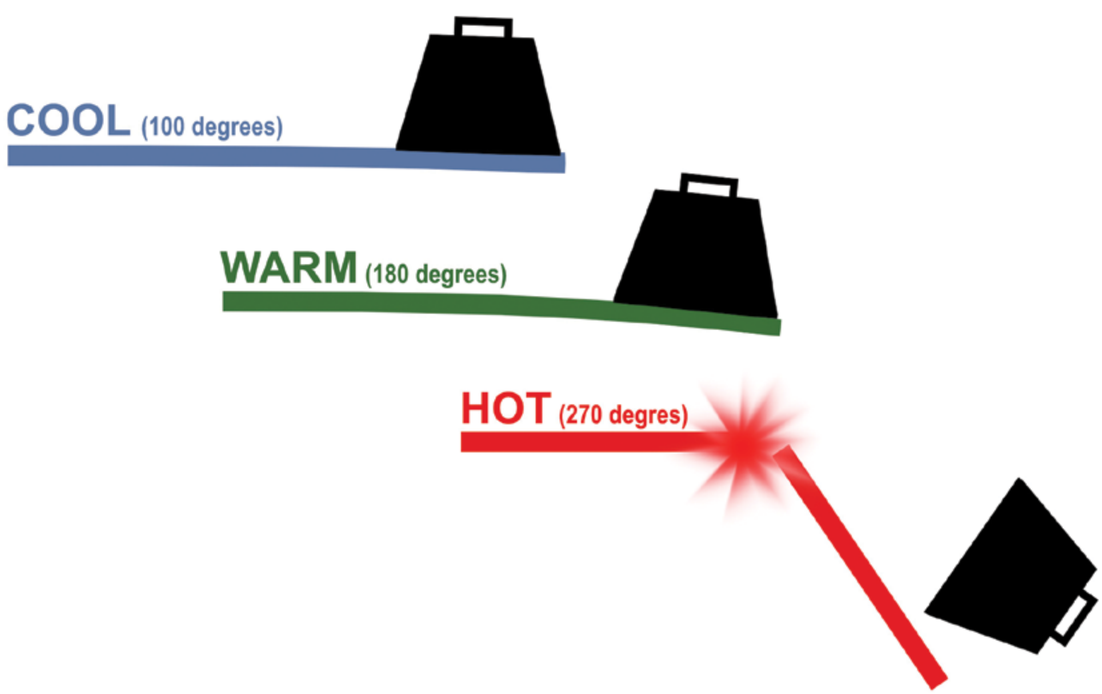
An internal combustion engine has precision machined metal parts that are designed to run against other metal surfaces. There needs to be a layer of oil between those surfaces at all times. If you were to run an engine and pull the oil plug and let all the oil drain out, after just minutes, the engine would run hot, slow down, and ultimately seize up completely from the metal on metal friction.

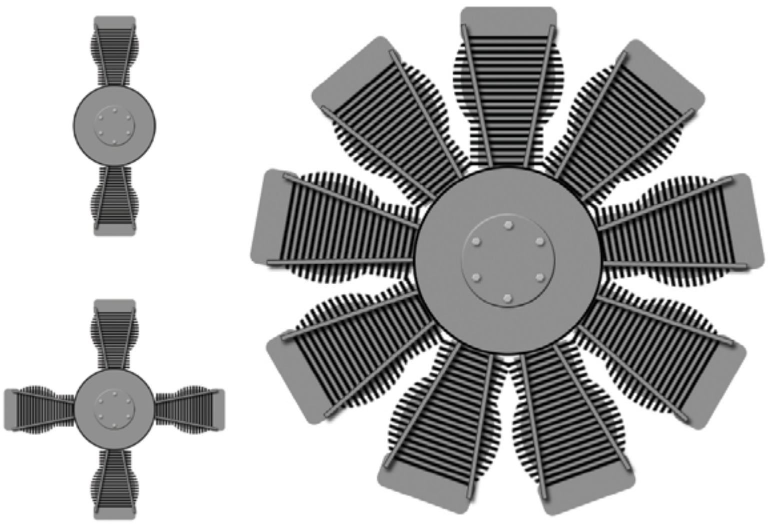
There is a minimum amount of oil pressure required for every engine to run safely. If the oil pressure falls below this minimum, then the engine parts are in danger of making contact with each other and incurring damage. A trained pilot quickly learns to look at his oil pressure gauge as soon as the engine starts, because if the oil pressure does not rise within seconds, then the engine must be shut down immediately.



Without the layer of oil between the parts, an engine will quickly overheat and seize.

Above is a simple illustration of a crankshaft that is located between two metal caps, bolted together. This is the very crankshaft where all of the engine's power ends up. Vital oil is pressure-injected in between these surfaces when the engine is running. The only time the crankshaft ever physically touches these metal caps is at startup and shutdown. The moment oil pressure drops below its minimum, these surfaces make contact. The crankshaft is where all the power comes from, so if you starve this vital component of oil, the engine can seize. However, this is just one of hundreds of moving parts in an engine that need a constant supply of oil to run properly.





MORE CYLINDERS, MORE POWER

The very first combustion engines were just one or two cylinders. Then, as technology advanced, and the demand for more power increased, cylinders were made larger. Ultimately, they were not only made larger, but more were added to an engine.

Below are some illustrations to show how an engine may be configured as more cylinders are added.

The more cylinders you add to an engine, the more heat it produces. Eventually, engine manufacturers started to add additional “rows” of cylinders. Sometimes two engines would literally be mated together, with the 2nd row being rotated slightly so the cylinders could get a direct flow of air.

THE PRATT + WHITNEY R4360

Pratt & Whitney took this even further, creating the R4360, with 28 Cylinders (this engine is featured in the A2A Boeing 377 Stratocruiser). The cylinders were run so deep, it became known as the “Corn Cob.” This is the most powerful piston aircraft engine to reach production. There are a LOT of moving parts on this engine.

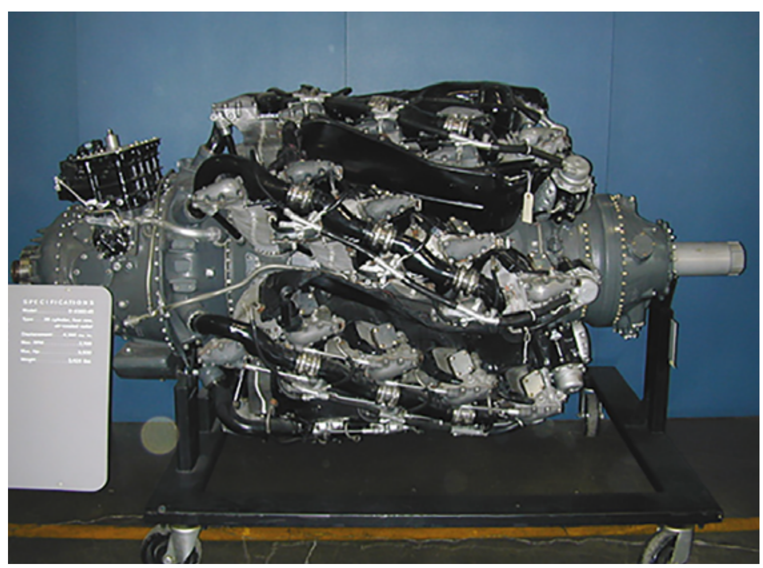
TORQUE VS HORSEPOWER

Torque is a measure of twisting force. If you put a foot long wrench on a bolt, and applied 1 pound of force at the handle, you would be applying 1 foot-pound of torque to that bolt. The moment a spark triggers an explosion, and that piston is driven down, that is the moment that piston is creating torque, and using that torque to twist the crankshaft. With a more powerful explosion, comes more torque. The more fuel and air that can be exploded, the more torque. You can increase an engine’s power by either making bigger cylinders, adding more cylinders, or both.

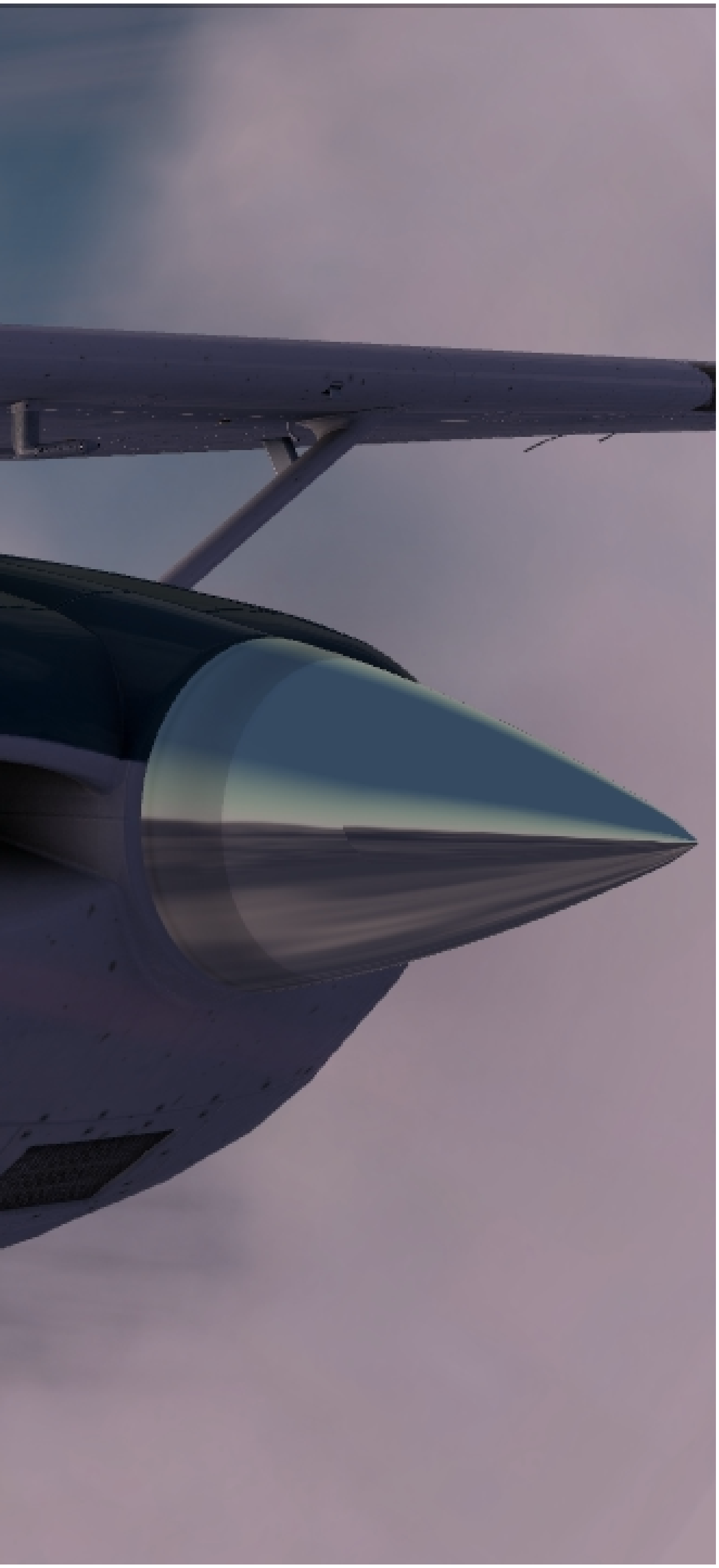
Horsepower, on the other hand, is the total power that engine is creating. Horsepower is calculated by combining torque with speed (RPM). If an engine can produce 500 foot pounds of torque at 1,000 RPM and produce the same amount of torque at 2,000 RPM, then that engine is producing twice the horsepower at 2,000 RPM than it is at 1,000 RPM. Torque is the twisting force. Horsepower is how fast that twisting force is being applied.

If your airplane has a torque meter, keep that engine torque within the limits or you can break internal components. Typically, an engine produces the most torque in the low to mid RPM range, and highest horsepower in the upper RPM range.

The “Corn Cob,” the most powerful piston aircraft engine to reach production.



SPECIFICATIONS



PERFORMANCE SPECIFICATIONS

Speeds

Note that high speed figures are with wheel fairings. Subtract 2 KIAS when removed.

Maximum at Sea Level: *150 ktas*

Cruise, 80% Power at 7000 ft: *145 ktas*

Range

Recommended lean mixture with fuel allowance for engine start, taxi, takeoff, climb and 45 minutes reserve.

80% Power @ 7000 ft (max): *773 nm / 5.4 hrs*

55% Power @ 10000 ft (econ): *Range 930 nm / 7.6 hrs*

Rate Of Climb At Sea Level

924 fpm

Service Ceiling

18,100 ft

Takeoff

Ground Roll: *795 ft*

Total Distance Over 50 ft Obstacle: *1514 ft*

Landing

Ground Roll: *590 ft*

Total Distance Over 50 ft Obstacle: *1350 ft*

Stall Speed

Flaps Up, Power Off: *54 kcas*

Flaps Down, Power Off: *49 kcas*

SPECIFICATIONS

GENERAL

Engine

Textron Lycoming, IO-540-AB1A5, Normally aspirated, direct drive, air-cooled, horizontally opposed, fuel injected, six cylinder engine with 541 cu. in. displacement.

Horsepower Rating and Engine Speed:
230 rated BHP at 2,400 RPM.

Propeller

Three blade, constant speed, 79” 14.9° to 31.7° pitch McCauley, Model Number B3D36C431/80VSA-1.

Fuel

Total Capacity: *92.0 U.S. gallons.*
Total Usable: *87.0 U.S. gallons.*
Total Capacity Each Tank: *46.0 U.S. gallons.*
Total Usable Each Tank: *43.5 U.S. gallons.*
Specified Octane: *100LL Grade Aviation Fuel*

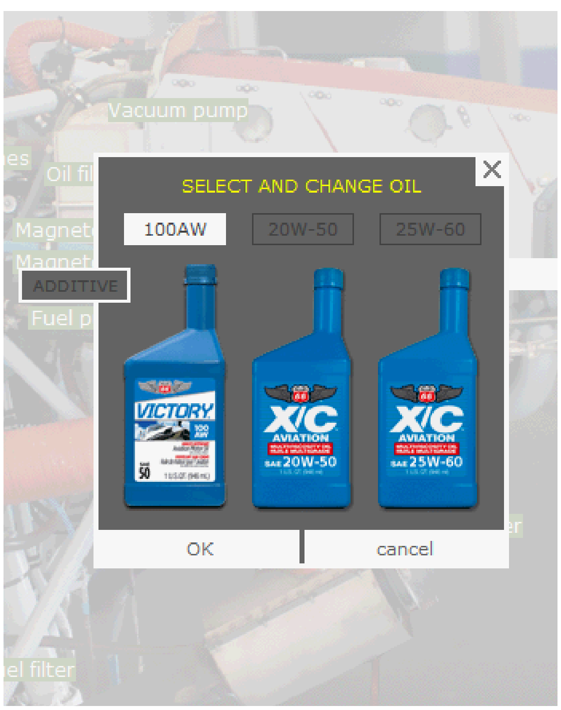
Oil Capacity

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

Recommended Oil Viscosity for Temperature Range:

Temperature	SAE Grade
Above 16°C (60°F)	50 (w100)
-18°C (0°F) to 32°C (90°F)	20W-50
All Temperatures	15W-50

NOTE: The oil viscosity listed in the manual are slightly different than in the simulation because they are each referencing a different name brand of aviation oil.



Max Weights

Max Takeoff Weight: *3100 lbs.*
Max Baggage Area Weight: *200lbs*
Max Ramp Weight: *3110 lbs*
Max Landing Weight: *2950 lbs*

Standard Airplane Weights

Standard Empty Weight: *1918 lbs.*
Maximum Useful Load (total fuel, passengers, and baggage): *1192 lbs*

Limitations

VNE (Never Exceed)
Do not exceed 175 KIAS in any speed operation.

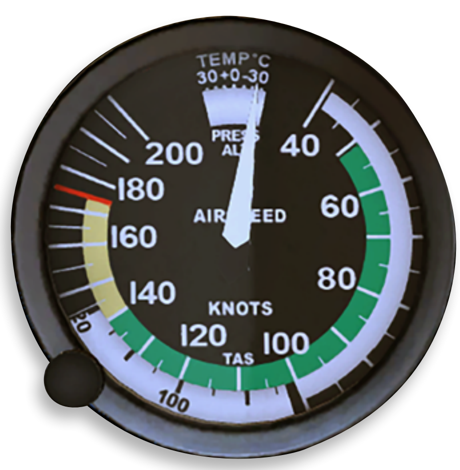
VNO (Maximum Structural)
Do not exceed 140 KIAS except in smooth air, and then only with caution.

VA (Maneuvering Speed)
Do not make full or abrupt control movements above this speed.
- **3,100 Pounds:** *110 KIAS*
- **2,600 Pounds:** *101 KIAS*
- **2,100 Pounds:** *91 KIAS*

VFE (Maximum Flap Speed)
Do not exceed this speed with flaps
- **10° Flaps:** *140 KIAS*
- **10° to 20° Flaps:** *120 KIAS*
- **20° to 30° Flaps:** *100 KIAS*

Airspeed Indicator Markings

White Arc (flaps extended)
Full Flap Operating Range (41 – 100 KIAS)
Green Arc (flaps retracted)
Normal Operating Range (51 – 140 KIAS)
Yellow Arc
Operations must be conducted with caution and only in smooth air (140-175 KIAS)
Red Line
Maximum speed for all operations is 175 KIAS



Powerplant Limitations

Maximum Engine Speed: *2400 RPM*
Maximum Cylinder Head Temperature: *500° F (260° C)*
Maximum Oil Temperature: *245°F (118°C)*
Oil Pressure Minimum: *20 PSI*
Oil Pressure Maximum: *115 PSI*

Center Of Gravity Limits

NORMAL CATEGORY
Center of Gravity Range: *Forward: 33.0 inches aft of datum at 2250 pounds or less, with straight line variation to 35.5 inches aft of datum at 2700 pounds or less, with straight line variation to 40.9 inches aft of datum at 3100 pounds, continuing to aft limit at 3100 pounds.*
Aft: *46.0 inches aft of datum at all weights.*
Reference Datum: *Lower portion of front face of firewall.*

Maneuver Limits

This airplane is certificated in the normal category. The normal category is applicable to aircraft intended for non aerobatic operations. These include any maneuvers incidental to normal flying, stalls (except whip stalls), lazy eights, chandelles, and turns in which the angle of bank is not more than 60°. Aerobatic maneuvers, including spins, are not approved.

Flight Load Factor Limits

Flight Load Factors (Maximum Takeoff Weight - 3100 lbs.):
***Flaps Up:** *+3.8g, -1.52g*
***Flaps FULL:** *+2.0g*
*The design load factors are 150% of the above, and in all cases, the structure meets or exceeds design loads.

NORMAL OPERATIONS

Airspeeds For Normal Operation

Unless otherwise noted, the following speeds are based on a maximum weight of 3100 pounds and may be used for any lesser weight.

Takeoff
Normal Climb: *70-80 KIAS*
Short Field Takeoff, Flaps 20°, Speed at 50 Feet: *58 KIAS*

Enroute Climb, Flaps Up
Normal, Sea Level: *85-95 KIAS*
Best Rate-of-Climb, Sea Level: *80 KIAS*
Best Rate-of-Climb, 10,000 Feet: *74 KIAS*
Best Angle-of-Climb, Sea Level: *65 KIAS*
Best Angle-of-Climb, 10,000 Feet: *68 KIAS*

Landing Approach
Normal Approach, Flaps Up: *70-80 KIAS*
Normal Approach, Flaps FULL: *60-70 KIAS*
Short Field Approach, Flaps FULL: *60 KIAS*

Balked Landing
Maximum Power, Flaps 20°: *55 KIAS*

Maximum Recommended Turbulent Air Penetration Speed
3100 lbs: *110 KIAS*
2600 lbs: *101 KIAS*
2100 lbs: *91 KIAS*

Maximum Demonstrated Crosswind Velocity
Takeoff or Landing: *15 KTS*

CHECKLISTS

CABIN

1. **Pitot Tube Cover —** REMOVE. Check for pitot blockage.
2. **Pilot's Operating Handbook —** ACCESSIBLE TO PILOT.
3. **Airplane Weight and Balance —** CHECKED.
4. **Parking Brake —** SET.
5. **Control Wheel Lock —** REMOVE.
6. **Ignition Switch —** OFF.
7. **Avionics Master Switch —** OFF.

WARNING: When turning on the master switch, using an external power source, or pulling the propeller through by hand, treat the propeller as if the ignition switch were on. Do not stand, nor allow anyone else to stand, within the arc of the propeller, since a loose or broken wire or a component malfunction could cause the propeller to rotate.

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

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

15. **Fuel Selector Valve —** BOTH.
16. **Flaps —** EXTEND.
17. **Pitot Heat —** ON. (Carefully check that pitot tube is warm to the touch within 30 seconds.)
18. **Stall Warning System —** CHECK (gently move the stall vane upward and verify that the stall warning horn is heard)
19. **Pitot Heat —** OFF.
20. **Master Switch —** OFF.
21. **Trim Controls —** Neutral.
22. **Baggage Door —** CHECK, lock with key.

BEFORE STARTING ENGINE

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

   NOTE: The avionics master switch must be off during engine start to prevent possible damage to avionics.

7. **Avionics Master Switch —** OFF.
8. **Cowl Flaps —** OPEN
9. **Fuel Selector Valve —** BOTH.
10. **Avionics Circuit Breakers —** CHECK IN.

STARTING ENGINE (WITH BATTERY)

1. **Throttle —** OPEN ¼ INCH.
2. **Propeller —** HIGH RPM
3. **Mixture —** IDLE CUTOFF.
4. **Propeller Area —** CLEAR.
5. **Master Switch —** ON.
6. **Flashing Beacon —** ON.

   NOTE: If engine is warm, omit priming procedure of steps 7, 8, and 9 below.

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

    NOTE: If engine floods (engine has been primed too much), turn off auxiliary fuel pump, set mixture to idle cutoff, open throttle ½ to full, and motor (crank) engine. When engine starts, set mixture to full rich and close throttle promptly.

12. **Oil Pressure —** CHECK.
13. **Ammeter —** CHECK (charging)
14. **Navigation Lights —** ON as required.
15. **Taxi and Landing Light Switches —** ON as required
16. **Avionics Master Switch —** ON.
17. **Radios —** ON.
18. **Flaps —** RETRACT.

BEFORE TAKEOFF

1. **Parking Brake —** SET.
2. **Passenger Seat Backs —** MOST UPRIGHT POSITION.
3. **Seats and Seat Belts —** CHECK SECURE.
4. **Cabin Doors —** CLOSED and LOCKED.
5. **Flight Controls —** FREE and CORRECT.
6. **Flight Instruments —** CHECK and SET.
7. **Fuel Quantity —** CHECK.
8. **Mixture —** RICH.
9. **Fuel Selector Valve —** RECHECK BOTH.
10. **Elevator and Rudder Trim** — SET for takeoff
11. **Throttle —** 1800 RPM.
    a. **Magnetos —** CHECK (RPM drop should not exceed 175 RPM on either magneto or 50 RPM differential between magnetos).
    b. **Propeller Control —** CYCLE (from high to low RPM; return to high RPM) (push full in)
    c. **Vacuum Gage —** CHECK.
    d. **Engine Instruments and Ammeter —** CHECK.
12. **Annunciator Panel —** Ensure no annunciators are illuminated.
13. **Throttle —** CHECK IDLE.
14. **Throttle —** 1000 RPM or LESS.
15. **Throttle Friction Lock —** ADJUST.
16. **Strobe Lights —** AS DESIRED.
17. **Radios and Avionics —** SET.
18. **NAV/GPS Switch (if installed) —** SET.
19. **Autopilot (if installed) —** OFF.
20. **Cabin Windows —** CLOSED and LOCKED.
21. **Wing Flaps —** SET for takeoff (0°-20°)
22. **Cowl Flaps —** OPEN
23. **Brakes —** RELEASE

NORMAL TAKEOFF

1. **Wing Flaps —** 0°-20°.
2. **Power —** FULL THROTTLE and 2400 RPM.
3. **Mixture —** RICH (above 5000 feet pressure altitude, lean for maximum RPM)
4. **Elevator Control —** LIFT NOSE WHEEL (at 50-60 KIAS).
5. **Climb Speed —** 70 KIAS (flaps 20°) or 80 KIAS (flaps 0°)
6. **Wing Flaps —** RETRACT.

SHORT FIELD TAKEOFF

1. **Wing Flaps —** 20°.
2. **Brakes —** APPLY.
3. **Power —** FULL THROTTLE and 2400 RPM.
4. **Mixture —** L RICH (above 5000 feet pressure altitude, lean for maximum RPM)
5. **Brakes —** RELEASE.
6. **Elevator Control —** MAINTAIN SLIGHTLY TAIL LOW ATTITUDE.
7. **Climb Speed —** 60 KIAS (until all obstacles are cleared).
8. **Wing Flaps —** RETRACT slowly after reaching 70 KIAS.

ENROUTE CLIMB

1. **Airspeed —** 85-95 KIAS.
2. **Power —** 23 in. Hg or FULL THROTTLE (whichever is less) and 2400 RPM.
3. **Mixture —** 15 GPH or FULL RICH (whichever is less)
4. **Fuel Selector Valve —** BOTH
5. **Cowl Flaps —** OPEN AS REQUIRED

CRUISE

1. **Power —** 15-23 in. Hg, 2000-2400 RPM (no more than 80%).
2. **Elevator and Rudder Trim —** ADJUST.
3. **Mixture —** LEAN.
4. **Cowl Flaps —** CLOSED

DESCENT

1. **Power —** AS DESIRED.
2. **Mixture —** ENRICHEN as required.
3. **Cowl Flaps —** CLOSED
4. **Altimeter —** SET.
5. **NAV/GPS Switch —** SET.
6. **Fuel Selector Valve —** BOTH.
7. **Wing Flaps —** AS DESIRED (0°-10° below 140 KIAS, 10°-20° below 120 KIAS, FULL below 100 KIAS).

BEFORE LANDING

1. **Pilot and Passenger Seat Backs —** MOST UPRIGHT POSITION.
2. **Seats and Seat Belts —** SECURED and LOCKED.
3. **Fuel Selector Valve —** BOTH.
4. **Mixture —** RICH.
5. **Propeller —** HIGH RPM
6. **Landing/Taxi Lights —** ON.
7. **Autopilot —** OFF.

NORMAL LANDING

1. **Airspeed —** 70-80 KIAS (flaps UP).
2. **Wing Flaps —** AS DESIRED (0°-10° below 140 KIAS, 10°-20° below 120 KIAS, FULL below 100 KIAS).
3. **Airspeed —** 60 KIAS (Flaps FULL).
4. **Trim —** ADJUST
5. **Touchdown —** MAIN WHEELS FIRST.
6. **Landing Roll —** LOWER NOSE WHEEL GENTLY.
7. **Braking —** MINIMUM REQUIRED.

SHORT FIELD LANDING

1. **Airspeed —** 70-80 KIAS (flaps UP).
2. **Wing Flaps —** FULL (below 100 KIAS).
3. **Airspeed —** 60 KIAS (until flare).
4. **Trim —** ADJUST
5. **Touchdown —** MAIN WHEELS FIRST.
6. **Brakes —** APPLY HEAVILY.
7. **Wing Flaps —** RETRACT for maximum brake effectiveness.

BALKED LANDING

1. **Throttle —** FULL OPEN and 2400RPM
2. **Wing Flaps —** RETRACT TO 20°.
3. **Climb Speed —** 55 KIAS.
4. **Wing Flaps —** 10° (until obstacles are cleared). Retract (after reaching a safe altitude and 70 KIAS).

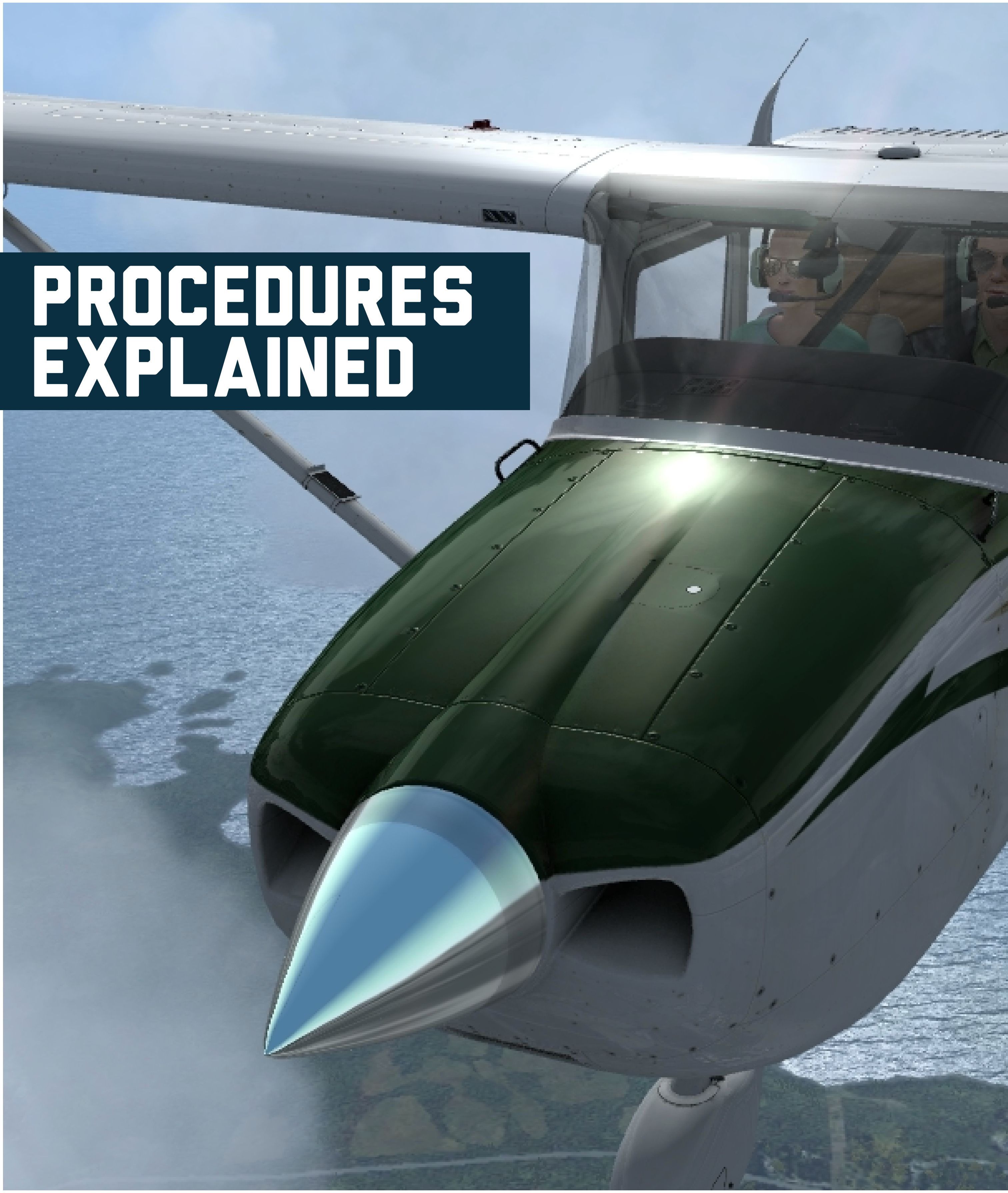
AFTER LANDING

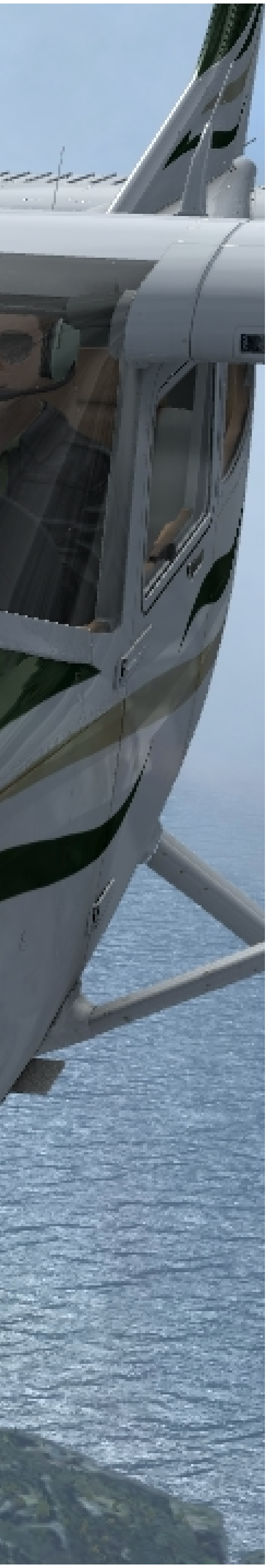
1. **Wing Flaps —** UP.
2. **Cowl Flaps —** OPEN

SECURING AIRPLANE

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

PROCEDURES EXPLAINED





STARTING ENGINE

When the engine starts, smoothly advance the mixture control to full rich and retard the throttle to desired idle speed. If the engine is under primed (most likely in cold weather with a cold engine) it will not start at all, and additional priming will be necessary. After starting, if the oil pressure gauge does not begin to indicate pressure within 30 seconds in the summer time and approximately one minute in very cold weather, stop the engine and investigate. Lack of oil pressure can cause serious engine damage.

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

RECOMMENDED STARTER DUTY CYCLE

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

LEANING FOR GROUND OPERATIONS

For all ground operations, after starting the engine and when the engine is running smoothly:

1. Set the throttle to 1200 RPM.
2. Lean the mixture for maximum RPM.
3. Set the throttle to an RPM appropriate for ground operations (800 to 1000 RPM recommended)

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

TAXIING

When taxiing, it is important that speed and use of brakes be held to a minimum and that all controls be utilized to maintain directional control and balance. Taxiing over loose gravel or cinders should be done at low engine speed to avoid abrasion and stone damage to the propeller tips.

BEFORE TAKEOFF

WARM UP

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

MAGNETO CHECK

The magneto check should be made at 1800 RPM as follows. Move ignition switch first to R position and note RPM. Next move switch back to BOTH to clear the other set of plugs. Then move switch to the L position, note RPM and return the switch to the BOTH position. RPM drop should not exceed 175 RPM on either magneto or show greater than 50 RPM differential between magnetos. If there is a doubt concerning operation of the ignition system, RPM checks at higher engine speeds will usually confirm whether a deficiency exists. An absence of RPM drop may be an indication of faulty grounding of one side of the ignition system or should be cause for suspicion that the magneto timing is set in advance of the setting specified.

ALTERNATOR CHECK

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

LANDING LIGHTS

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

TAKEOFF

POWER CHECK

It is important to check full throttle engine operation early in the takeoff roll. Any sign of rough engine operation or sluggish engine acceleration is good cause for discontinuing the takeoff. If this occurs, you are justified in making a thorough full throttle static run-up before another takeoff is attempted. The engine should run smoothly and turn approximately 2350 - 2400 RPM.

Full throttle run-ups over loose gravel are especially harmful to propeller tips. When takeoffs must be made over a gravel surface, advance the throttle slowly. This allows the airplane to start rolling before high RPM is developed, and the gravel will be blown behind the propeller rather than pulled into it.

Prior to takeoff from fields above 5000 feet pressure elevation, the mixture should be leaned to give maximum RPM at full throttle, with the airplane not moving. This mixture setting should provide a fuel flow that closely matches that shown on the Maximum Power Fuel Flow placard. After full throttle is applied, adjust the throttle friction lock clockwise to prevent the throttle from moving back from a maximum power position. Similar friction lock adjustments should be made as required in other flight conditions to hold the throttle setting.

WING FLAP SETTINGS

Normal takeoffs use wing flaps UP - 20° (10° preferred). Using 20° wing flaps reduces the ground roll and total distance over an obstacle by approximately 20 percent. Flap deflections greater than 20° are not approved for takeoff. If 20° wing flaps are used for takeoff, the flaps should stay at 20° until all obstacles are cleared and a safe flap retraction speed of 70 KIAS is reached. For a short field, 20° wing flaps and an obstacle clearance speed of 60 KIAS should be used.

Soft or rough field takeoffs are performed with 20° flaps by lifting the airplane off the ground as soon as practical in a slightly tail low attitude. If no obstacles are ahead, the airplane should be leveled off immediately to accelerate to a higher climb speed. When departing a soft field with an aft C.G. loading, the elevator trim control should be adjusted towards the nose down direction to give comfortable control wheel forces during the initial climb.

CROSSWIND TAKEOFF

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

ENROUTE CLIMB

Normal enroute climbs are performed with flaps up, at 23 in.hg. manifold pressure or full throttle, whichever is less, 2400 RPM, and 85 to 95 KIAS for the best combination of performance, visibility, engine cooling, economy and passenger comfort (due to lower noise level). The mixture should be full rich during climb at altitudes up to 5000 feet pressure altitude.

If it is necessary to climb more rapidly to clear mountains or reach favorable winds at higher altitudes, the best rate of climb speed should be used with MCP. This speed is 80 KIAS at sea level, decreasing to 74 KIAS at 10,000 feet. For maximum power climb use full throttle and 2400 RPM with the mixture set in accordance with the Maximum Power Fuel Flow placard.

If an obstruction dictates the use of a steep climb angle, the best angle of climb speed should be used with flaps up and maximum power. This speed is 64 KIAS at sea level, increasing to 68 KIAS at 20,000 feet. This type of climb should be of the minimum duration and engine temperatures should be carefully monitored due to the low climb speed. For maximum power, the mixture should be set in accordance with the Maximum Power Fuel Flow placard. The fuel flow values on the placard are minimum fuel flows.

MAXIMUM POWER FUEL FLOW

Altitude	Fuel Flow
S.L.	20.5 GPH
2000 Feet	19.0 GPH
4000 Feet	17.5 GPH
6000 Feet	16.5 GPH
8000 Feet	15.5 GPH
10,000 Feet	14.5 GPH
12,000 Feet	13.5 GPH

CRUISE

Normal cruise is performed between 55% and 80% of the rated MCP. However, any power setting within the green arc ranges on the manifold pressure indicator and tachometer may be used. The power setting and corresponding fuel consumption for various altitudes can be determined by using the data in the Performance Section.

NOTE Cruise flight should use 75% power as much as possible until the engine has operated for a total of 50 hours or oil consumption has stabilized. Operation at this higher power will ensure proper seating of the piston rings and is applicable to new engines, and engines in service following cylinder replacement or top overhaul of one or more cylinders.

The Cruise Performance charts provide the pilot with flight planning information for the Model 182T in still air with speed fairings installed. Power, altitude, and winds determine the time and fuel needed to complete any flight.

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

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

For reduced noise levels, it is desirable to select the lowest RPM in the green arc range for a given percent power that will provide smooth engine operation. The cowl flaps should be opened, if necessary, to maintain the cylinder head temperature at approximately two-thirds of the normal operating range (green band).

The Cruise Performance charts provide the pilot with cruise performance at maximum gross weight. When normal cruise is performed at reduced weights there is an increase in true airspeed. During normal cruise at power settings between 55% and 80%, the true airspeed will increase approximately 1 knot for every 150 pounds below maximum gross weight. During normal cruise at power settings below 70%, the true airspeed will increase approximately 1 knot for every 125 pounds below maximum gross weight.

The fuel injection system employed on this engine is considered to be non-icing. In the event that unusual conditions cause the intake air filter to become clogged or iced over, an alternate intake air door opens automatically for the most efficient use of either normal or alternate air, depending on the amount of filter blockage. Due to the lower intake pressure available through the alternate air door or a partially blocked filter, manifold pressure can decrease from a cruise power setting. This manifold pressure should be recovered by increasing the throttle setting or setting a higher RPM as necessary to maintain desiredpower.

CRUISE PERFORMANCE TABLE

ALTITUDE	80% POWER		75% POWER		65% POWER		55% POWER	
	KTAS	NMPG	KTAS	NMPG	KTAS	NMPG	KTAS	NMPG
Sea Level	141	10.2	138	10.6	129	11.3	118	11.8
4,000 feet	144	10.4	140	10.8	131	11.4	120	12.0
8,000 feet	---	---	142	11.0	133	11.6	122	12.1
10,000 feet	---	---	---	---	135	11.8	124	12.3

LEANING USING THE EGT INDICATOR

At or below 80% power in level cruise flight, the exhaust gas temperature (EGT) indicator is used to lean the fuel-air mixture for best performance or economy. The Cruise Performance charts are based on the EGT to adjust the mixture to Recommended Lean per EGT Table below:

MIXTURE DESCRIPTION	EGT
Recommended Lean	50° Rich of Peak EGT
Best Economy	Peak EGT
Best Power	125° Rich of Peak EGT

Operation at peak EGT provides the best fuel economy. This results in approximately 4% greater range than shown in this POH accompanied by approximately a 3 knot decrease in speed. Under some conditions, engine roughness may occur while operating at peak EGT. In this case, operate at the recommended lean mixture.

NOTE: Any change in altitude or power setting will require a change in the recommended lean mixture setting and a recheck of the EGT setting. The EGT indicators take several seconds, after a mixture adjustment, to start to show EGT changes. Finding peak EGT and adjusting the mixture to the applicable setting should take approximately one minute when the adjustments are made carefully and accurately. Adjusting the mixture quickly is not recommended.

FUEL SAVINGS PROCEDURES FOR FLIGHT TRAINING OPERATIONS

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

1. After engine start and for all ground operations, set the throttle to 1200 RPM and lean the mixture for maximum RPM. After leaning, set the throttle to the appropriate RPM for ground operations. Leave the mixture at this setting until beginning the BEFORE TAKEOFF checklist. After the BEFORE TAKEOFF checklist is complete, lean the mixture again as described above, until ready to perform the TAKEOFF checklist.
2. Adjust the mixture for placarded fuel flows during MCP climbs.
3. Lean the mixture at any altitude for RECOMMENDED LEAN or BEST ECONOMY fuel flows when using 80% or less power.

NOTE Using the above recommended procedures can provide fuel savings in excess of 5% when compared to typical training operations at full rich mixture. In addition, the above procedures will minimize spark plug fouling since the reduction in fuel consumption results in a proportional reduction in tetraethyl lead passing through the engine.

STALLS

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

LANDING

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

Landing at slower speeds will result in shorter landing distances and minimum wear to tires and brakes. Power must be at idle as the main wheels touch the ground. The main wheels must touch the ground before the nosewheel. The nosewheel must be lowered to the runway carefully after the speed has diminished to avoid unnecessary nose gear loads. This procedure is very important for rough or soft field landings.

SHORT FIELD LANDING

For a short field landing in smooth air conditions, approach at 60 KIAS with FULL flaps using enough power to control the glide path. Slightly higher approach speeds should be used in turbulent air conditions. After all approach obstacles are cleared, smoothly reduce power and hold the approach speed by lowering the nose of the airplane. The main wheels must touch the ground before the nosewheel with power at idle. Immediately after the main wheels touch the ground, carefully lower the nosewheel and apply heavy braking as required. For maximum brake performance, retract the flaps, hold the control wheel full back, and apply maximum brake pressure without skidding the tires.

CROSSWIND LANDING

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

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

Balked Landing

In a balked landing (go-around) climb, reduce the flap setting to 20° immediately after full power is applied and climb at 55 KIAS. Above 5000 feet pressure altitude, lean the mixture to obtain maximum RPM. After clearing any obstacles, carefully retract the flaps and allow the airplane to accelerate to normal climb airspeed.

Cold Weather Operation

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

Hot Weather Operation

Avoid prolonged engine operation on the ground.

PERFORMANCE

PERFORMANCE DATA CHARTS ON THE following pages are presented so that you may know what to expect from the airplane under various conditions, and also, to facilitate the planning of flights in detail and with reasonable accuracy. The data in the charts has been computed from actual flight tests with the airplane and engine in good condition and approximating average piloting techniques. It should be noted that performance information presented in the range and endurance profile charts allows for 45 minutes reserve fuel at the specified power setting. Fuel flow data for cruise is based on the recommended lean mixture setting at all altitudes. Some indeterminate variables such as mixture leaning technique, fuel metering characteristics, engine and propeller condition, and air turbulence may account for variations of 10% or more in range and endurance. Therefore, it is important to utilize all available information to estimate the fuel required for the particular flight and to flight plan in a conservative manner.

STALL SPEEDS AT 3100 POUNDS

CONDITIONS: Power Off

NOTES

1. Altitude loss during a stall recovery may be as much as 250 feet.
2. KIAS values are approximate.

MOST REARWARD CENTER OF GRAVITY

Flap Setting	Angle of Bank			
	0º	**30º**	**45º**	**60º**
UP	50	54	59	71
20º	43	46	51	61
FULL	40	43	48	57

MOST FORWARD CENTER OF GRAVITY

Flap Setting	Angle of Bank			
	0º	**30º**	**45º**	**60º**
UP	51	55	61	72
20º	44	47	52	62
FULLº	41	44	49	58

NOTE: Maximum demonstrated crosswind component is 15 KTS (not a limitation).

SHORT FIELD TAKEOFF DISTANCE

CONDITIONS:

- ▶ Flaps 20°
- ▶ 2400 RPM, Full Throttle and Mixture set Prior to Brake Release
- ▶ Cowl Flaps OPEN
- ▶ Paved, level, dry runway
- ▶ Zero Wind

Lift Off 49 KIAS
Speed at 50 ft: 58 KIAS

NOTES:

1. Short field technique as specified.
2. Prior to takeoff, the mixture should be leaned to the Maximum Power Fuel Flow schedule in a full throttle, static run-up.
3. Decrease distances 10% for each 9 knots head-wind. For operation with tail winds up to 10 knots, increase distances by 10% for each 2 knots.
4. Where distance value have been deleted, climb performance after lift-off is less than 150 FPM at takeoff speed.
5. • For operation on dry, grass runway, increase distances by 15% of the "ground roll" figure.
6. Where distance value has been deleted, climb performance is minimal.

SHORT FIELD TAKEOFF DISTANCE AT 3100 POUNDS

Pressure Altitude - Feet	0°C		10°C		20°C		30°C		40°C	
	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst
Sea Level	715	1365	765	1460	825	1570	885	1680	945	1800
1000	775	1490	835	1600	900	1720	965	1845	1030	1980
2000	850	1635	915	1760	980	1890	1055	2035	1130	2190
3000	925	1800	995	1940	1070	2090	1150	2255	1235	2435
4000	1015	1990	1090	2150	1175	2325	1260	2515	1355	2720
5000	1110	2210	1195	2395	1290	2595	1385	2820	1485	3070
6000	1220	2470	1315	2690	1415	2930	1520	3200	1635	3510
7000	1340	2785	1445	3045	1560	3345	1675	3685	---	---
8000	1480	3175	1595	3500	1720	3880	---	---	---	---

SHORT FIELD TAKEOFF DISTANCE AT 2300 POUNDS

Pressure Altitude - Feet	0°C		10°C		20°C		30°C		40°C	
	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst
Sea Level	365	705	390	750	420	800	450	850	480	905
1000	395	765	425	815	455	870	490	925	520	985
2000	430	830	460	885	495	940	530	1005	565	1070
3000	470	900	505	960	540	1025	580	1090	620	1165
4000	510	980	550	1045	590	1115	630	1190	675	1270
5000	555	1065	600	1140	640	1220	690	1305	735	1390
6000	610	1165	655	1250	700	1335	755	1430	805	1530
7000	665	1275	715	1370	770	1470	825	1570	885	1685
8000	730	1405	785	1510	845	1620	905	1735	970	1865

SHORT FIELD TAKEOFF DISTANCE AT 2700 POUNDS

Pressure Altitude - Feet	0°C		10°C		20°C		30°C		40°C	
	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst
Sea Level	520	995	560	1065	600	1135	645	1215	690	1295
1000	565	1080	610	1155	655	1235	700	1320	750	1410
2000	615	1180	665	1260	710	1350	765	1445	820	1545
3000	675	1285	725	1380	775	1480	835	1585	895	1695
4000	735	1410	790	1510	850	1625	910	1740	975	1870
5000	805	1550	865	1665	930	1790	1000	1920	1070	2065
6000	880	1705	950	1840	1020	1980	1095	2135	1175	2300
7000	965	1890	1040	2040	1120	2205	1200	2380	1290	2575
8000	1060	2100	1145	2275	1230	2465	1320	2675	1420	2910

MAXIMUM RATE-OF-CLIMB AT 3100 POUNDS

CONDITIONS:

- ► Flaps UP
- ► 2400 RPM, Full Throttle and mixture set to Maximum Power Fuel Flow Placard.
- ► Cowl Flaps OPEN

Pressure Altitude - Feet	Climb Speed - KIAS	Rate of Climb - FPM			
		-20°C	0°C	20°C	40°C
Sea Level	80	1055	980	905	835
2000	79	945	875	805	735
4000	78	840	770	705	635
6000	77	735	670	605	535
8000	75	625	560	495	430
10,000	74	520	455	390	330
12,000	73	410	350	285	225
14,000	72	310	250	190	130

TIME, FUEL AND DISTANCE TO CLIMB AT 3100 POUNDS

CONDITIONS:

- Flaps UP
- 2400 RPM, Full Throttle and mixture set to Maximum Power Fuel Flow Placard.
- Cowl Flaps OPEN
- Standard Temperature

NOTES:

1. Add 1.7 gallons of fuel for engine start, taxi and takeoff allowance.
2. Increase time, fuel and distance by 10% for each 10°C above standard temperature.
3. Distances shown are based on zero wind.

MAXIMUM RATE OF CLIMB

Pressure Altitude Feet	Climb Speed KIAS	Rate of Climb FPM	From Sea Level		
			Time Minutes	Fuel Used Gallons	Distance NM
Sea Level	80	925	0	0.0	0
2000	79	835	2	0.8	3
4000	78	750	5	1.5	7
6000	77	660	8	2.3	11
8000	75	565	11	3.2	16
10,000	74	470	15	4.2	21
12,000	73	375	20	5.2	29
14,000	72	285	26	6.5	38

NORMAL CLIMB - 90 KIAS

Pressure Altitude Feet	Climb Speed KIAS	Rate of Climb FPM	From Sea Level		
			Time Minutes	Fuel Used Gallons	Distance NM
Sea Level	90	665	0	0.0	0
2000	90	625	3	0.8	5
4000	90	580	6	1.6	10
6000	90	540	10	2.5	16
8000	90	455	14	3.5	23
10,000	90	370	19	4.6	31

CRUISE PERFORMANCE

CONDITIONS:

- 3100 Pounds
- Recommended Lean Mixture
- Cowl Flaps CLOSED

PRESSURE ALTITUDE SEA LEVEL

RPM	MP	20°C BELOW STANDARD TEMP -5°C			STANDARD TEMPERATURE 15°C			20°C ABOVE STANDARD TEMP 35°C		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2400	27	---	---	---	---	---	---	---	---	---
	26	---	---	---	---	---	---	82	140	14.3
	25	84	134	14.5	81	136	14.0	78	138	13.5
	24	79	132	13.6	76	133	13.2	74	135	12.8
	23	74	129	12.8	71	130	12.4	69	131	12.1
	22	69	126	12.1	67	127	11.7	65	127	11.4
	21	65	122	11.4	62	122	11.1	60	123	10.8
	20	60	118	10.7	58	118	10.4	56	118	10.2
2300	27	---	---	---	---	---	---	84	141	14.5
	26	---	---	---	82	137	14.2	79	139	13.7
	25	80	133	13.9	78	135	13.4	75	136	13.0
	24	76	130	13.2	73	132	12.7	71	132	12.3
	23	71	127	12.4	69	128	12.0	67	129	11.7
	22	67	124	11.7	65	124	11.4	62	125	11.1
	21	62	120	11.1	60	120	10.8	58	121	10.5
	20	58	116	10.4	56	116	10.2	54	116	9.9
2200	27	---	---	---	83	137	14.4	80	139	13.9
	26	82	133	14.2	79	135	13.6	76	136	13.2
	25	77	131	13.4	75	133	12.9	72	134	12.6
	24	73	129	12.7	71	130	12.3	68	130	11.9
	23	69	126	12.0	66	126	11.7	64	126	11.3
	22	65	122	11.4	62	122	11.1	60	123	10.8
	21	60	118	10.8	58	119	10.5	56	118	10.2
	20	56	114	10.2	54	114	9.9	52	114	9.7
2100	27	82	133	14.2	79	135	13.7	76	136	13.2
	26	78	131	13.4	75	133	13.0	73	134	12.6
	25	74	129	12.8	71	130	12.4	69	130	12.0
	24	70	126	12.1	67	127	11.8	65	127	11.4
	23	66	123	11.5	63	123	11.2	61	123	10.9
	22	61	119	10.9	59	120	10.6	57	120	10.4
	21	57	115	10.4	55	116	10.1	54	115	9.9
	20	53	111	9.8	51	111	9.6	50	111	9.3
2000	27	78	131	13.4	75	133	13.0	72	134	12.6
	26	74	129	12.8	71	130	12.4	69	131	12.0
	25	70	126	12.2	67	127	11.8	65	127	11.5
	24	66	123	11.6	64	124	11.3	62	124	11.0
	23	62	120	11.0	60	120	10.7	58	121	10.5
	22	58	116	10.5	56	117	10.2	54	116	10.0
	21	54	113	10.0	53	112	9.7	51	112	9.5
	20	51	108	9.4	49	108	9.2	47	108	9.0

NOTE:

1. Maximum cruise power is 80% MCP. Power settings above 80% are listed to aid interpolation.
2. For best economy, operate at peak EGT.

PRESSURE ALTITUDE 2000 FEET

RPM	MP	20°C BELOW STANDARD TEMP -9°C			STANDARD TEMPERATURE 11°C			20°C ABOVE STANDARD TEMP 31°C		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2400	26	---	---	---	---	---	---	---	---	---
	25	---	---	---	83	140	14.4	80	142	13.9
	24	81	136	14.1	79	138	13.6	76	139	13.2
	23	77	133	13.3	74	134	12.8	71	135	12.4
	22	72	130	12.5	69	131	12.1	67	131	11.7
	21	67	126	11.8	65	126	11.4	63	127	11.1
	20	62	122	11.0	60	122	10.7	58	122	10.5
2300	26	---	---	---	---	---	---	82	143	14.2
	25	83	137	14.4	80	139	13.9	77	140	13.4
	24	78	134	13.6	76	136	13.1	73	137	12.7
	23	74	131	12.8	71	133	12.4	69	133	12.0
	22	69	128	12.1	67	128	11.7	65	129	11.4
	21	65	124	11.4	62	124	11.1	60	125	10.8
	20	60	120	10.7	58	120	10.5	56	120	10.2
2200	26	---	---	---	81	139	14.1	78	140	13.6
	25	80	135	13.8	77	137	13.3	74	138	12.9
	24	75	132	13.1	73	134	12.6	70	134	12.3
	23	71	129	12.4	69	130	12.0	66	130	11.6
	22	67	126	11.7	64	126	11.4	62	127	11.0
	21	62	122	11.1	60	122	10.8	58	122	10.5
	20	58	118	10.5	56	118	10.2	54	118	9.9
2100	26	80	135	13.9	77	137	13.4	75	138	12.9
	25	76	133	13.1	73	134	12.7	71	134	12.3
	24	72	130	12.5	69	131	12.1	67	131	11.7
	23	68	127	11.8	65	127	11.5	63	127	11.2
	22	64	123	11.2	61	123	10.9	59	124	10.6
	21	59	119	10.6	57	119	10.4	55	119	10.1
	20	55	115	10.1	53	115	9.8	52	115	9.6
2000	26	76	133	13.1	73	134	12.7	71	134	12.3
	25	72	130	12.5	69	131	12.1	67	131	11.8
	24	68	127	11.9	66	127	11.5	64	128	11.2
	23	64	124	11.3	62	124	11.0	60	124	10.7
	22	60	120	10.8	58	120	10.5	56	120	10.2
	21	56	116	10.2	54	116	10.0	53	116	9.7
	20	52	112	9.7	51	112	9.4	49	111	9.2

PRESSURE ALTITUDE 4000 FEET

RPM	MP	20°C BELOW STANDARD TEMP -13°C			STANDARD TEMPERATURE 7°C			20°C ABOVE STANDARD TEMP 27°C		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2400	25	---	---	---	---	---	---	83	146	14.4
	24	84	140	14.6	81	142	14.0	78	143	13.6
	23	79	138	13.7	76	139	13.2	74	139	12.8
	22	74	134	12.9	72	135	12.5	69	135	12.1
	21	70	130	12.1	67	131	11.7	65	131	11.4
	20	65	126	11.4	62	126	11.1	60	126	10.8
2300	25	---	---	---	83	143	14.3	80	144	13.8
	24	81	138	14.0	78	140	13.5	75	141	13.1
	23	76	135	13.2	74	137	12.8	71	137	12.4
	22	72	132	12.5	69	133	12.1	67	133	11.7
	21	67	128	11.7	65	128	11.4	62	129	11.1
	20	62	124	11.1	60	124	10.7	58	124	10.5
2200	25	82	139	14.2	79	141	13.7	77	142	13.2
	24	78	136	13.4	75	138	13.0	72	138	12.6
	23	73	133	12.7	71	134	12.3	68	134	11.9
	22	69	130	12.0	66	130	11.7	64	130	11.3
	21	65	126	11.4	62	126	11.0	60	126	10.7
	20	60	122	10.7	58	122	10.4	56	121	10.2
2100	25	78	137	13.5	75	138	13.0	73	138	12.6
	24	74	134	12.8	71	135	12.4	69	135	12.0
	23	70	131	12.2	67	131	11.8	65	131	11.4
	22	66	127	11.5	63	127	11.2	61	127	10.9
	21	61	123	10.9	59	123	10.6	57	123	10.3
	20	57	119	10.3	55	119	10.1	53	118	9.8
2000	25	74	134	12.8	71	135	12.4	69	135	12.1
	24	70	131	12.2	68	131	11.8	65	132	11.5
	23	66	127	11.6	64	128	11.3	62	128	11.0
	22	62	124	11.0	60	124	10.7	58	124	10.4
	21	58	120	10.5	56	120	10.2	54	120	9.9
	20	54	116	9.9	52	115	9.7	51	115	9.4

RPM	MP	20°C BELOW STANDARD TEMP -17°C			STANDARD TEMPERATURE 3°C			20°C ABOVE STANDARD TEMP 23°C		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2400	23	82	142	14.2	79	143	13.6	76	144	13.2
	22	77	138	13.3	74	139	12.8	72	139	12.4
	21	72	135	12.5	69	135	12.1	67	135	11.7
	20	67	130	11.7	65	130	11.4	62	131	11.1
	19	62	126	11.0	60	126	10.7	58	125	10.4
2300	23	79	140	13.6	76	141	13.1	73	141	12.7
	22	74	136	12.8	71	137	12.4	69	137	12.0
	21	69	132	12.1	67	133	11.7	64	133	11.4
	20	65	128	11.4	62	128	11.0	60	128	10.7
	19	60	124	10.7	58	123	10.4	56	123	10.1
2200	23	76	137	13.1	73	138	12.6	70	138	12.3
	22	71	134	12.4	69	134	12.0	66	135	11.6
	21	67	130	11.7	64	130	11.3	62	130	11.0
	20	62	126	11.0	60	126	10.7	58	125	10.4
	19	58	121	10.4	56	121	10.1	54	120	9.9
2100	23	72	135	12.5	69	135	12.1	67	135	11.7
	22	68	131	11.8	65	131	11.5	63	131	11.1
	21	63	127	11.2	61	127	10.9	59	127	10.6
	20	59	123	10.6	57	122	10.3	55	122	10.0
	19	55	118	10.0	53	118	9.8	51	117	9.5
2000	23	68	131	11.9	66	132	11.5	63	132	11.2
	22	64	127	11.3	62	128	11.0	60	128	10.7
	21	60	124	10.7	58	123	10.4	56	123	10.2
	20	56	119	10.2	54	119	9.9	52	118	9.7
	19	52	115	9.6	50	114	9.4	48	113	9.1

PRESSURE ALTITUDE 8000 FEET

RPM	MP	20°C BELOW STANDARD TEMP -21°C			STANDARD TEMPERATURE -1°C			20°C ABOVE STANDARD TEMP 19°C		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2400	21	74	139	12.9	72	139	12.5	69	140	12.1
	20	69	134	12.1	67	135	11.7	65	135	11.4
	19	64	130	11.4	62	130	11.0	60	130	10.7
	18	59	125	10.6	57	124	10.3	55	124	10.1
2300	21	72	136	12.5	69	137	12.0	67	137	11.7
	20	67	132	11.7	64	132	11.3	62	132	11.0
	19	62	128	11.0	60	127	10.7	58	127	10.4
	18	57	122	10.3	55	122	10.1	53	121	9.8
2200	21	69	134	12.0	66	134	11.6	64	134	11.3
	20	64	130	11.3	62	130	11.0	60	129	10.7
	19	60	125	10.7	57	125	10.4	55	124	10.1
	18	55	120	10.1	53	119	9.8	51	119	9.5
2100	21	65	131	11.5	63	131	11.2	61	131	10.8
	20	61	127	10.9	59	126	10.6	57	126	10.3
	19	57	122	10.3	55	121	10.0	53	121	9.7
	18	52	117	9.7	50	116	9.4	49	115	9.2
2000	21	62	128	11.0	60	127	10.7	58	127	10.4
	20	58	123	10.4	56	123	10.1	54	122	9.9
	19	54	118	9.9	52	118	9.6	50	117	9.4

PRESSURE ALTITUDE 10,000 FEET

RPM	MP	20°C BELOW STANDARD TEMP -25°C			STANDARD TEMPERATURE -5°C			20°C ABOVE STANDARD TEMP 15°C		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2400	20	72	139	12.5	69	139	12.1	67	139	11.7
	19	67	134	11.7	64	134	11.3	62	134	11.0
	18	62	129	11.0	59	129	10.6	57	128	10.3
2300	21	74	141	12.8	71	141	12.4	69	142	12.0
	20	69	136	12.1	66	137	11.7	64	136	11.3
	19	64	132	11.3	62	132	11.0	60	131	10.7
	18	59	126	10.6	57	126	10.3	55	125	10.1
2200	20	66	134	11.6	64	134	11.3	62	133	10.9
	19	62	129	11.0	59	129	10.6	57	128	10.4
	18	57	124	10.3	55	123	10.0	53	123	9.8
2100	20	63	131	11.2	61	130	10.8	59	130	10.5
	19	59	126	10.5	56	125	10.2	54	125	10.0
	18	54	121	9.9	52	120	9.7	50	119	9.4
2000	20	60	127	10.7	58	127	10.4	55	126	10.1
	19	56	122	10.1	54	122	9.8	52	121	9.6
	18	51	117	9.6	50	116	9.3	48	115	9.0

PRESSURE ALTITUDE 12,000 FEET

RPM	MP	20°C BELOW STANDARD TEMP -29°C			STANDARD TEMPERATURE -9°C			20°C ABOVE STANDARD TEMP 11°C		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2400	18	64	133	11.3	61	133	10.9	59	133	10.6
	17	59	127	10.5	56	127	10.2	54	126	10.0
	16	53	121	9.8	51	120	9.6	50	119	9.3
2300	18	61	131	10.9	59	130	10.6	57	130	10.3
	17	56	125	10.2	54	124	10.0	52	123	9.7
	16	52	118	9.6	50	118	9.3	48	117	9.0
2200	18	59	128	10.6	57	128	10.3	55	127	10.0
	17	54	122	9.9	52	121	9.7	50	121	9.4
2100	18	56	125	10.2	54	124	9.9	52	123	9.6
	17	52	119	9.6	50	118	9.3	48	117	9.1
2000	19	57	126	10.4	55	125	10.1	53	125	9.8
	18	53	121	9.8	51	120	9.5	49	119	9.3

PRESSURE ALTITUDE 14,000 FEET

RPM	MP	20°C BELOW STANDARD TEMP -33°C			STANDARD TEMPERATURE -13°C			20°C ABOVE STANDARD TEMP 7°C		
		% MCP	KTAS	GPH	% MCP	KTAS	GPH	% MCP	KTAS	GPH
2400	16	56	126	10.1	53	125	9.8	51	124	9.6
	15	50	118	9.4	48	117	9.1	47	116	8.9
2300	16	53	123	9.8	51	122	9.6	50	121	9.3
2200	16	51	120	9.6	49	119	9.3	48	118	9.0
2100	16	49	116	9.2	47	115	8.9	45	114	8.7

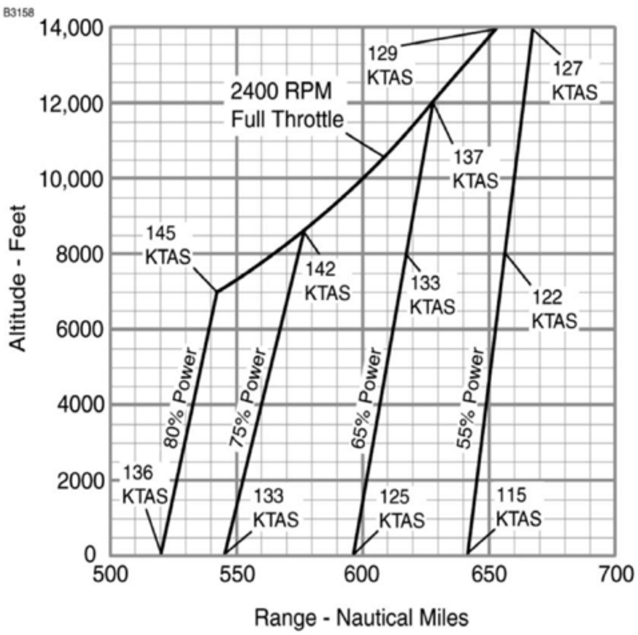
RANGE PROFILE

CONDITIONS:

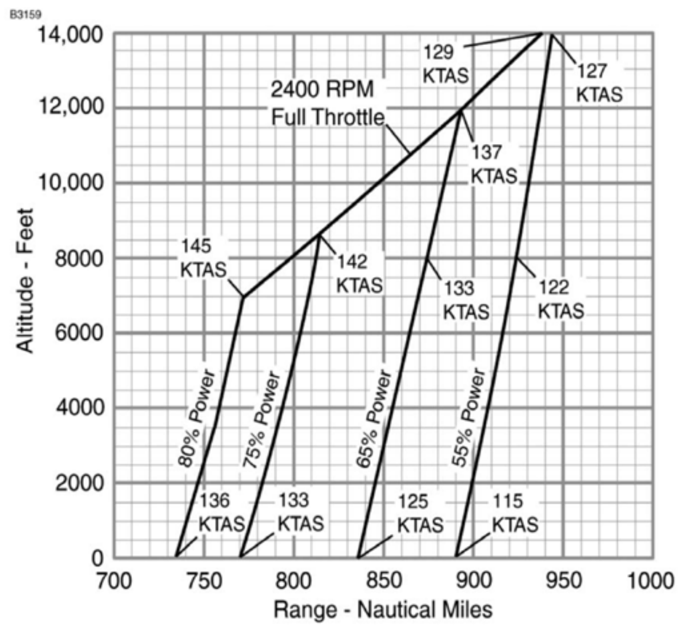
- ► 3100 Pounds
- ► Normal Climb to 10,000 feet then, Maximum Performance Climb, with Placard Mixture
- ► Recommended Lean Mixture for CruiseStandard Temperature
- ► Zero Wind

NOTES: **This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the distance during a normal climb up to 10,000 feet and maximum climb above 10,000 feet.**

45 MINUTES RESERVE
64 GALLONS USABLE FUEL



45 MINUTES RESERVE
87 GALLONS USABLE FUEL



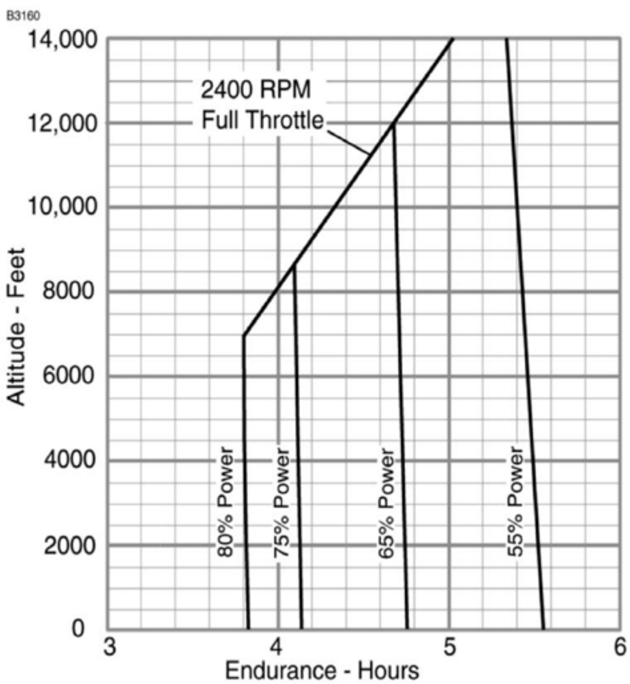
ENDURANCE PROFILE

CONDITIONS:

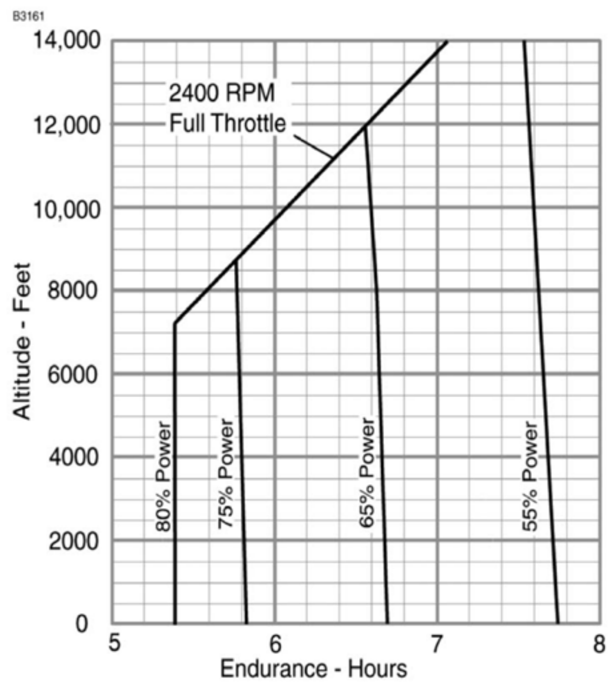
- 3100 Pounds
- Normal Climb to 10,000 feet then, Maximum Performance Climb, with Placard Mixture
- Recommended Lean Mixture for CruiseStandard Temperature
- Zero Wind

NOTES: This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the distance during a normal climb up to 10,000 feet and maximum climb above 10,000 feet.

45 MINUTES RESERVE
64 GALLONS USABLE FUEL



45 MINUTES RESERVE
87 GALLONS USABLE FUEL



SHORT FIELD LANDING DISTANCE AT 2950 POUNDS

CONDITIONS:

- ▶ Flaps FULL
- ▶ Zero Wind
- ▶ Power IDLE
- ▶ Paved, Level, Dry Runway
- ▶ Maximum Braking
- ▶ Speed at 50 ft: 60 KIAS

NOTE

1. Short field technique as specified in Section 4.
2. Decrease distances 10% for each 9 knots headwind. For operation with tail winds up to 10 knots, increase distances by 10% for each 2 knots.
3. For operation on dry grass runway, increase distances by 45% of the “ground roll” figure.
4. If landing with flaps up, increase the approach speed by 10 KIAS and allow for 40% longer distances.

Pressure Altitude - Feet	0°C		10°C		20°C		30°C		40°C	
	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst	Gnd Roll Feet	Total Feet To Clear 50 Foot Obst
Sea Level	560	1300	580	1335	600	1365	620	1400	640	1435
1000	580	1265	600	1365	620	1400	645	1440	665	1475
2000	600	1370	625	1405	645	1440	670	1480	690	1515
3000	625	1410	645	1445	670	1485	695	1525	715	1560
4000	650	1450	670	1485	695	1525	720	1565	740	1600
5000	670	1485	695	1525	720	1565	745	1610	770	1650
6000	700	1530	725	1575	750	1615	775	1660	800	1700
7000	725	1575	750	1615	780	1665	805	1710	830	1750
8000	755	1625	780	1655	810	1715	835	1760	865	1805

EMERGENCY PROCEDURES

THIS SECTION PROVIDES CHECKLIST AND EXPLAINED PROCEDURES for coping with emergencies that may occur. Emergencies caused by airplane or engine malfunctions are extremely rare if proper preflight inspections and maintenance are practiced. En-route weather emergencies can be minimized or eliminated by careful flight planning and good judgment when unexpected weather is encountered. However, should an emergency arise, the basic guidelines described in this section should be considered and applied as necessary to correct the problem. In any emergency situation, the most important task is continued control of the airplane and maneuver to execute a successful landing.

AIRSPEEDS FOR EMERGENCY OPERATION

Engine Failure After Takeoff
Wing Flaps Up: 75 KIAS
Wing Flaps Down: 70 KIAS

Maneuvering Speed
3100 lbs: 110 KIAS
2600 lbs: 101 KIAS
2100 lbs: 91 KIAS

Maximum Glide
3100 lbs: 76 KIAS
2600 lbs: 70 KIAS
2100 lbs: 58 KIAS

Precautionary Landing With Engine Power: 70 KIAS
Wing Flaps Up: 75 KIAS
Wing Flaps Down: 70 KIAS

ENGINE FAILURE DURING TAKEOFF ROLL

1. **Throttle —** IDLE.
2. **Brakes—** APPLY.
3. **Wing Flaps —** RETRACT.
4. **Mixture —** IDLE CUT OFF (pull full out).
5. **Magnetos Switch —** OFF.
6. **Master Switch (ALT and BAT) —** OFF.

ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

1. **Airspeed —** 75 KIAS (flaps UP)- 70 KIAS (flaps DOWN).
2. **Mixture —** IDLE CUT OFF (pull full out).
3. **FUEL SELECTOR Valve —** PUSH DOWN and ROTATE to OFF
4. **Magnetos Switch —** OFF.
5. **Wing Flaps —** AS REQUIRED (FULL recommended).
6. **Master Switch —** OFF.
7. **Cabin Door —** UNLATCH.
8. **Land —** STRAIGHT AHEAD.

ENGINE FAILURE DURING FLIGHT (RESTART PROCEDURES)

1. **Airspeed —** 76 KIAS (best glide speed)
2. **Fuel Selector Valve —** BOTH.
3. **Fuel Pump Switch —** ON.
4. **Mixture —** RICH (if restart has not occurred).
5. **Magnetos Switch —** BOTH (or START if propeller is stopped).

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

6. **Fuel Pump Switch —** OFF.

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

RED TYPE = commit to memory.

EMERGENCY LANDING WITHOUT ENGINE POWER

1. **Passenger Seat Backs —** MOST UPRIGHT POSITION.
2. **Seats and Seat Belts —** SECURE.
3. **Airspeed —** 75 KIAS - Flaps UP 70 KIAS - Flaps 10° - FULL
4. **Mixture —** IDLE CUT OFF (pull full out).
5. **FUEL SELECTOR Valve —** PUSH DOWN and ROTATE to OFF
6. **magnetos Switch —** OFF.
7. **Wing Flaps —** AS REQUIRED (FULL recommended).
8. **Master Switch (ALT and BAT) —** OFF (when landing is assured).
9. **Doors —** UNLATCH PRIOR TO TOUCHDOWN.
10. **Touchdown —** SLIGHTLY TAIL LOW.
11. **Brakes —** APPLY HEAVILY.

PRECAUTIONARY LANDING WITH ENGINE POWER

1. **Passenger Seat Backs —** MOST UPRIGHT POSITION.
2. **Seats and Seat Belts —** SECURE.
3. **Airspeed —** 75 KIAS.
4. **Wing Flaps —** 20°.
5. **Selected Field —** FLY OVER, noting terrain and obstructions.
6. **Avionics Master Switch and Electrical Switches —** OFF.
7. **Wing Flaps —** FULL (on final approach).
8. **Airspeed —** 70 KIAS.
9. **Master Switch (ALT and BAT) —** OFF.
10. **Doors —** UNLATCH PRIOR TO TOUCHDOWN.
11. **Touchdown —** SLIGHTLY TAIL LOW.
12. **Mixture —** IDLE CUT OFF (pull full out).
13. **Magnetos Switch —** OFF.
14. **Brakes —** APPLY HEAVILY.

RED TYPE = commit to memory.

FIRE DURING START ON GROUND

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

If engine starts:

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

If engine fails to start:

4. **Throttle —** FULL OPEN (push full in).
5. **Mixture —** IDLE CUT OFF (pull full out).
6. **MAGNETOS Switch —** START (continue cranking)
7. **Fuel Selector Valve —** OFF
8. **Fuel Pump —** OFF.
9. **MAGNETOS Switch —** OFF
10. **MASTER Switch (Alt and BAT) —** OFF
11. **Engine —** SECURE
12. **Parking Brake —** RELEASE.
13. **Fire Extinguisher —** OBTAIN (have ground attendants obtain if not installed).
14. **Airplane —** EVACUATE.
15. **Fire —** EXTINGUISH using fire extinguisher, wool blanket, or dirt.
16. **Fire Damage —** INSPECT, repair damage or replace damaged components or wiring before conducting another flight.

ENGINE FIRE IN FLIGHT

1. **Mixture —** IDLE CUT OFF.
2. **FUEL SELECTOR Valve —** PUSH DOWN and ROTATE to OFF
3. **Fuel Pump Switch —** OFF.
4. **Master Switch (ALT and BAT) —** OFF.
5. **Cabin Vents —** OPEN (as needed)
6. **Cabin Heat and Air —** OFF (push full in).
7. **Airspeed —** 100 KIAS (If fire is not extinguished, increase glide speed to find an airspeed - within airspeed limitations - which will provide an incombustible mixture).
8. **Forced Landing —** EXECUTE (as described in Emergency Landing Without Engine Power).

AMMETER SHOWS EXCESSIVE RATE OF CHARGE (FULL SCALE DEFLECTION)

1. **Alternator —** OFF.
2. **Nonessential Electrical Equipment —** OFF.
3. **Flight —** TERMINATE as soon as practical.

RED TYPE = commit to memory.

LOW VOLTAGE ANNUNCIATOR (VOLTS) ILLUMINATES DURING FLIGHT (AMMETER INDICATES DISCHARGE)

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

1. **Avionics Master Switch —** OFF.
2. **Alternator Circuit Breaker (ALT FLD) —** CHECK IN.
3. **Master Switch —** OFF (both sides).
4. **Master Switch —** ON.
5. **Low Voltage Annunciator (VOLTS) —** CHECK OFF.
6. **Avionics Master Switch —** ON.
   If low voltage annunciator (VOLTS) illuminates again:
7. **Alternator—** OFF.
8. **Nonessential Radio and Electrical Equipment —** OFF.
9. **Flight —** TERMINATE as soon as practical.

VACUUM SYSTEM FAILURE

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

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

1. **Vacuum Gauge —** CHECK to ensure vacuum within normal operating limits.

RED TYPE = commit to memory.

EMERGENCIES EXPLAINED

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

Engine Failure

If an engine failure occurs during the takeoff roll, the most important thing to do is stop the airplane on the remaining runway. Those extra items on the checklist will provide added safety after a failure of this type. Prompt lowering of the nose to maintain airspeed and establish a glide attitude is the first response to an engine failure after takeoff. In most cases, the landing should be planned straight ahead with only small changes in direction to avoid obstructions. Altitude and airspeed are seldom sufficient to execute a 180° gliding turn necessary to return to the runway. The checklist procedures assume that adequate time exists to secure the fuel and ignition systems prior to touchdown. After an engine failure in flight, the most important course of action is to continue flying the airplane. Best glide speed should be established as quickly as possible. While gliding toward a suitable landing area, an effort should be made to identify the cause of the failure. If time permits, an engine restart should be attempted as shown in the checklist. If the engine cannot be restarted, a forced landing without power must be completed.

Forced Landings

If all attempts to restart the engine fail and a forced landing is imminent, select a suitable field and prepare for the landing as discussed under the Emergency Landing Without Engine Power checklist. Transmit Mayday message on 121.5 MHz giving location and intentions and squawk 7700. Before attempting an "off airport" landing with engine power available, one should fly over the landing area at a safe but low altitude to inspect the terrain for obstructions and surface conditions, proceeding as discussed under the Precautionary Landing With Engine Power checklist. Prepare for ditching by securing or jettisoning heavy objects located in the baggage area and collect folded coats for protection of occupants' face at touchdown. Transmit Mayday message on 121.5 MHz giving location and intentions and squawk 7700. Avoid a landing flare because of difficulty in judging height over a water surface. The checklist assumes the availability of power to make a precautionary water landing. If power is not available, use of the airspeeds noted with minimum flap extension will provide a more favorable attitude for a power off ditching. In a forced landing situation, do not set the AVIONICS MASTER switch or the airplane MASTER switch to the OFF position until a landing is assured. When these switches are in the OFF position, the airplane electrical systems are de-energized. Before performing a forced landing, especially in remote and mountainous areas, activate the ELT transmitter by positioning the cockpit-mounted switch to the ON position.

LANDING WITHOUT ELEVATOR CONTROL

Trim for horizontal flight with an airspeed of approximately 80 KIAS by using throttle and elevator trim controls. Then do not change the elevator trim control setting; control the glide angle by adjusting power exclusively. At flare out, the nose down moment resulting from power reduction is an adverse factor and the airplane may land on the nose wheel. Consequently, at flare, the elevator trim control should be adjusted toward the full nose up position and the power adjusted so that the airplane will rotate to the horizontal attitude for touchdown. Close the throttle at touchdown.

FIRES

Although engine fires are extremely rare in flight, the steps of the appropriate checklist should be followed if one is encountered. After completion of this procedure, execute a forced landing. Do not attempt to restart the engine. The initial indication of an electrical fire is usually the odor of burning insulation. The checklist for this problem should result in elimination of the fire.

TOTAL VACUUM SYSTEM FAILURE

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

SPINS

NEVER INTENTIONALLY SPIN an aircraft that is not designed and built to be spun (aerobatic aircraft).

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

1. Retard throttle to idle position.
2. Place ailerons in neutral position.
3. Apply and hold full rudder opposite to the direction of rotation.
4. Just after the rudder reaches the stop, move the control wheel briskly forward far enoughto break the stall.
5. Hold these control inputs until rotation stops. Premature relaxation of the control inputs may extend the recovery.
6. As rotation stops, neutralize rudder, and make a smooth recovery from the resulting dive.

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

ROUGH ENGINE OPERATION OR LOSS OF POWER

SPARK PLUG FOULING

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

MAGNETO MALFUNCTION

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

ENGINE-DRIVEN FUEL PUMP FAILURE

Failure of the engine-driven fuel pump will result in an immediate loss of engine power, similar to fuel exhaustion or starvation, but while operating from a fuel tank containing adequate fuel. A sudden reduction in indicated fuel flow will occur just before loss of engine power. If the engine-driven fuel pump fails, immediately set the auxiliary fuel pump switch (FUEL PUMP) to the ON position to restore engine power. The flight should be terminated as soon as practical and the engine-driven fuel pump repaired.

LOW OIL PRESSURE

If the low oil pressure annunciator (OIL PRESS) illuminates and oil temperature remains normal, the oil pressure sending unit or relief valve may be malfunctioning. Land at the nearest airport to inspect the source of trouble. If a total loss of oil pressure is accompanied by a rise in oil temperature, there is good reason to suspect an engine failure is imminent. Reduce engine power immediately and select a suitable forced landing field. Use only the minimum power required to reach the desired touchdown spot.

ELECTRICAL POWER SUPPLY SYSTEM MALFUNCTIONS

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

EXCESSIVE RATE OF CHARGE

After engine starting and heavy electrical usage at low engine speeds (such as extended taxiing) the battery condition will be low enough to accept above normal charging during the initial part of a flight. However, after thirty minutes of cruising flight, the ammeter should be indicating less than two needle widths of charging current. If the charging rate were to remain above this value on a long flight, the battery would overheat and evaporate the electrolyte at an excessive rate. Electronic components in the electrical system can be adversely affected by higher than normal voltage. The alternator control unit includes an overvoltage sensor which normally will automatically shut down the alternator if the charge voltage reaches approximately 31.5 volts. If the overvoltage sensor malfunctions, as evidenced by an excessive rate of charge shown on the ammeter, the alternator should be turned off, nonessential electrical equipment turned off and the flight terminated as soon as practical.

INSUFFICIENT RATE OF CHARGE

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

If the overvoltage sensor should shut down the alternator and trip the alternator circuit breaker (ALT FLD), or if the alternator output is low, a discharge rate will be shown on the ammeter followed by illumination of the low voltage annunciator (VOLTS). Since this may be a "nuisance" trip out, an attempt should be made to reactivate the alternator system. To reactivate, set the avionics master switch to the OFF position, check that the alternator circuit breaker (ALT FLD) is in, then set both sides of the master switch to the OFF position and then to the ON position. If the problem no longer exists, normal alternator charging will resume and the low voltage annunciator (VOLTS) will go off. The avionics master switch may then be returned to the ON position. If the annunciator illuminates again, a malfunction is confirmed. In this event, the flight should be terminated and/or the current drain on the battery minimized because the battery can supply the electrical system for only a limited period of time. Battery power must be conserved for later operation of the wing flaps and, if the emergency occurs at night, for possible use of the landing lights during landing.

AIRPLANE + SYSTEMS DESCRIPTION

THIS SECTION PROVIDES description and operation of the airplane and its systems.

FLIGHT CONTROLS

The airplane's flight control system consists of conventional aileron, rudder, and elevator control surfaces. The control surfaces are manually operated through cables and mechanical linkage using a control wheel for the ailerons and elevator, and rudder/brake pedals for the rudder.

TRIM SYSTEM

A manually operated rudder and elevator trim is provided. The rudder is trimmed through a bungee connected to the rudder control system and a trim control wheel mounted on the control pedestal. This is accomplished by rotating the horizontally mounted trim control wheel either left or right to the desired trim position. Rotating the trim wheel to the right will trim nose-right; conversely, rotating it to the left will trim nose-left. The elevator is trimmed through the elevator trim tab by utilizing the vertically mounted trim control wheel. Forward rotation of the trim wheel will trim nose-down, conversely, aft rotation will trim nose-up.

INSTRUMENT PANEL

The instrument panel is of all-metal construction, and is designed in segments to allow related groups of instruments, switches and controls to be removed without removing the entire panel. For specific details concerning the instruments, switches, circuit breakers, and controls on the instrument panel, refer to related topics in this section.

COCKPIT FAMILIARIZATION

The center panel contains various avionics equipment arranged in a vertical rack. This arrangement allows each component to be removed without having to access the backside of the panel. Below the panel are the throttle, mixture, alternate static air and lighting controls.

1. Oil Temperature and Oil Pressure Indicator
2. Fuel Quantity Indicators
3. Vacuum Gauge / Ammeter
4. EGT and CHT Indicator
5. Digital Clock / OAT Indicator
6. Turn Coordinator
7. Airspeed Indicator
8. Directional Indicator
9. Attitude Indicator
10. Tachometer
11. Vertical Speed Indicator
12. Altimeter
13. GPS Annunciator / Switch
14. ADF Indicator
15. Course Deviation Indicator 2
16. Course Deviation and Glide Slope Indicator 1
17. Annunciator Lights
18. Upper Panel
19. Callsign Panel
20. Day / Night / Test Switch
21. Audio Control Panel
22. GPS Receiver
23. Nav / Com Radio #1
24. Nav / Com Radio #2
25. ADF Receiver
26. Transponder
27. Autopilot
28. Distance Measuring Equipment (DME)
29. ELT Remote Switch / Annunciator
30. Hour Meter
31. Avionics Circuit Breaker Panel
32. Headset Inputs
33. Pilot's Operating Handbook
34. Glove Box
35. Cabin Defrost
36. Cabin Heat
37. Cabin Air
38. Flap Switch Lever and Indicator
39. Mixture Control
40. Propeller Control
41. Throttle Control
42. Rudder Trim
43. Cowl Flap Control Lever
44. Fuel Selector
45. Elevator Trim Control
46. Alternate Static Air Control
47. Glareshield and Pedestal Dimming Control
48. Radio Panel Dimming Control
49. Avionics Master Switch
50. Pitot Heat
51. Lights
52. Auxiliary Fuel Pump Switch
53. Master Switch
54. Ignition Switch
55. Controls Lock
56. Map
57. Manifold Pressure / Fuel Flow Indicator

GROUND CONTROL

Effective ground control while taxiing is accomplished through nose wheel steering by using the rudder pedals; left rudder pedal to steer left and right rudder pedal to steer right. When a rudder pedal is depressed, a spring loaded steering bungee (which is connected to the nose gear and to the rudder bars) will turn the nose wheel through an arc of approximately 11° each side of center. By applying either left or right brake, the degree of turn may be increased up to 29° each side of center.

WING FLAP SYSTEM

The single-slot type wing flaps, are extended or retracted by positioning the wing flap switch lever on the instrument panel to the desired flap deflection position. The switch lever is moved up or down in a slotted panel that provides mechanical stops at the 10°, 20° and 30° positions. To change flap setting, the flap lever is moved to the right to clear mechanical stops at the 10° and 20° positions. A scale and pointer to the left of the flap switch indicates flap travel in degrees. The wing flap system circuit is protected by a 10- ampere circuit breaker, labeled FLAP, on the left side of the control panel.

LANDING GEAR SYSTEM

The landing gear is of the tricycle type, with a steerable nose wheel and two main wheels. Wheel fairings are optional equipment for both the main and nose wheels. Shock absorption is provided by the tubular spring steel main landing gear struts and the air/oil nose gear shock strut. Each main gear wheel is equipped with a hydraulically actuated disc type brake on the inboard side of each wheel.

CONTROL LOCKS

A control lock is provided to lock the aileron and elevator control surfaces to prevent damage to these systems by wind buffeting while the airplane is parked. The lock consists of a shaped steel rod and flag. The flag identifies the control lock and cautions about its removal before starting the engine. To install the control lock, align the hole in the top of the pilot's control wheel shaft with the hole in the top of the shaft collar on the instrument panel and insert the rod into the aligned holes. Installation of the lock will secure the ailerons in a neutral position and the elevators in a slightly trailing edge down position. Proper installation of the lock will place the flag over the ignition switch. In areas where high or gusty winds occur, a control surface lock should be installed over the vertical stabilizer and rudder. The control lock and any other type of locking device should be removed prior to starting the engine.

MY ENGINE IS SMOKING

Remember, your engine is a piston-powered air pump. Valves open, a piston sucks in air / fuel, ignites it, another valve opens on the next stroke, and it ejects the burned mixture out the exhaust. During this time, oil below is lubricating those cylinder walls and piston rings keep that oil below and out of the combustion chamber. Well, all the above is how things are supposed to work, but as all things in life, nothing is perfect.

Blue Smoke

If your cylinders are worn or damaged, the cylinders can suck oil up past these rings. This oil is then present when the chamber combusts, burning it, and ejecting it. Two things happen. You will see blue smoke coming out the exhaust and oil sediments will build inside your combustion chamber, slowly degrading that cylinder's ability to properly work.

Black Smoke

Your engine is a vacuum pump, sucking in an air / fuel mixture, igniting it, then ejecting the burned remains. However, if you have a bad cylinder, a faulty ignition, fouled plugs, or fuel injection issues, the complete burning of the air / fuel mixture can be compromised. The result is black smoke (unburned fuel) seen coming out of the cylinders. If you see black smoke, get the aircraft on the ground and to a maintenance facility to find the cause of the problem.

ENGINE LUBRICATION SYSTEM

The engine utilizes a full pressure, wet sump type lubrication system with aviation grade oil as the lubricant. The capacity of the engine sump, located on the bottom of the engine, is nine quarts with one additional quart contained in the engine oil filter. Oil is drawn from the sump through a filter screen on the end of a pickup tube to the engine driven oil pump. Oil from the pump passes through a full-flow oil filter, a pressure relief valve at the rear of the right oil gallery, and a thermostatically controlled remote oil cooler. Oil from the remote cooler is then circulated to the left oil gallery and propeller governor. The engine parts are then lubricated by oil from the galleries. After lubricating the engine, the oil returns to the sump by gravity. The filter adapter in the full-flow filter is equipped with a bypass valve which will cause lubricating oil to bypass the filter in the event the filter becomes plugged, or the oil temperature is extremely cold.

An oil dipstick/filler tube is located on the upper left side of the engine case. The dipstick and oil filler tube are accessed through a door located on the left center portion of the upper engine cowling. The engine should not be operated on less than four quarts of oil. To minimize loss of oil through the breather, fill to eight quarts for normal flights of less than three hours. For extended flight, fill to nine quarts (dipstick indication only).

Oil Pressure

Oil is the lifeblood of your engine. The countless metal parts in motion depend on constantly having a film of oil covering and separating them. Theoretically, there should be no metal on metal contact, but pressurized oil in between. Some times simply having oil continuously splashed on the part is enough, yet other times actual pressure is required to keep these metal parts separated. The heavy crankshaft that is responsible for twisting the propeller is one part that is in critical need of this pressure at all times. Running the engine without oil pressure for just minutes is enough to seize up the engine.

Oil Temperature

Understanding how temperature affects the viscosity of the lubricant is very important (viscosity is the term used to describe the lubricants resistance to flow). As your engine oil increases in temperature, it's viscosity decreases, which means that it flows more freely. And vice-versa, as the lubricant cools down, it's viscosity increases, making it more resistant to flow.

Accusim models this effect of oil viscosity, so understanding how it affects you, the pilot, is important.

When you start your engine on a cold morning, know that the oil inside your engine has a high viscosity. You must be respectful of this, as pushing an engine with thick, cold oil can cause premature oil system leaks or worse.

If you must start a very cold engine, give it just enough throttle to keep it running (not so low that it is struggling to run). Hold the idle at the lowest possible RPM and wait for the oil temperature to rise. As it rises, the oil will thin, and you may also notice the RPM actually increase due to the thinner oil being easier to push through all those small areas. So ultimately, as the oil temperature rises the oil pressure drops.

IGNITION AND STARTER SYSTEM

Engine ignition is provided by two engine-driven magnetos, and two spark plugs in each cylinder. The right magneto fires the lower right and upper left spark plugs, and the left magneto fires the lower left and upper right spark plugs. Normal operation is conducted with both magnetos due to the more complete burning of the fuel/air mixture with dual ignition.

Ignition and starter operation is controlled by a rotary-type switch located on the left switch and control panel. The switch is labeled clockwise, OFF, R, L, BOTH, and START. The engine should be operated on both magnetos (BOTH position) except for magneto checks. The R and L positions are for checking purposes and emergency use only. When the switch is rotated to the spring loaded START position, (with the master switch in the ON position), the starter contactor is closed and the starter, now energized, will crank the engine. When the switch is released, it will automatically return to the BOTH position.

Electric Starter

The C182 Skylane has a direct-drive, electric starter, which functions very much the same way as the starter used in automobiles.

Turning the starter on, engages the starter motor to the engine, and it cranks the engine over with electricity. As the engine is turning over, the pilot is providing the engine with all of its fuel and ignition requirements, with the expectation the engine starts firing (combusting), and begins to run on its own power (using fuel and spark).

Once the engine reaches a certain speed, the starter motor automatically disengages and the engine runs free,

AIR INDUCTION SYSTEM

The engine air induction system receives ram air through an intake on the lower front portion of the engine cowling. The intake is covered by an air filter which removes dust and other foreign matter from the induction air. Airflow passing through the filter enters an air box. The air box has a spring-loaded alternate air door. If the air induction filter should become blocked, suction created by the engine will open the door and draw unfiltered air from inside the lower cowl area. An open alternate air door will result in an approximate 10% power loss at full throttle. After passing through the air box, induction air enters a fuel/air control unit under the engine, and is then ducted to the engine cylinders through intake manifold tubes.

EXHAUST SYSTEM

Exhaust gas from each cylinder passes through riser assemblies to a muffler and tailpipes. Outside air is pulled in around shrouds which are constructed around the outside of the muffler to form heating chambers which supply heat to the cabin.

COOLING SYSTEM

Ram air for engine cooling enters through two intake openings in the front of the engine cowling. The cooling air is directed from above the engine, around the cylinders and other areas of the engine by baffling, and then exits through cowl flaps on the lower aft edge of the cowling. The cowl flaps are mechanically operated from the cabin by means of the cowl flap control lever located on the right side of the control pedestal and is labeled OPEN, COWL FLAPS, CLOSED. Any time the control lever is repositioned, it must first be moved to the right to clear the detent.

Before starting the engine, before takeoff and during high power operation, the cowl flap control lever should be placed in the OPEN position for maximum cooling. This is accomplished by moving the control lever to the right to clear a detent, then moving the control lever up to the OPEN position.

While in cruise flight, cowl flaps should be closed unless hot day conditions require them to be adjusted to keep the CHT at approximately two-thirds of the normal operating range (green band).

During extended descents, it may be necessary to completely close the cowl flaps by pushing the cowl flap control lever down to the CLOSED position.

PROPELLER

The airplane has an all metal, three-bladed, constant speed, governor regulated propeller. A setting introduced into the governor with the propeller control establishes the propeller speed, and thus the engine speed to be maintained. The governor then controls flow of engine oil, boosted to high pressure by the governing pump, to or from a piston in the propeller hub. Oil pressure acting on the piston twists the blades toward high pitch (low RPM). When oil pressure to the piston in the propeller hub is relieved, centrifugal force, assisted by an internal spring, twists the blades toward low pitch (high RPM).

A propeller control knob, located on the lower center instrument panel, is used to set the propeller and control engine RPM as desired for various flight conditions. The control knob is labeled PROPELLER, PUSH INCR RPM. When the control knob is pushed in, blade pitch will decrease, giving a higher RPM. When the control knob is pulled out, the blade pitch increases, thereby decreasing RPM.

FUEL SYSTEM

The airplane fuel system consists of two vented integral fuel tanks (one tank in each wing), a three-position selector valve, auxiliary fuel pump, fuel shutoff valve, fuel strainer, engine driven fuel pump, fuel/air control unit, fuel distribution valve and fuel injection nozzles.

The fuel system also incorporates a fuel return system that returns fuel from the top of the fuel servo back to each integral wing tank. The system includes a flexible fuel hose assembly between the servo and the firewall. Aluminum fuel lines return the fuel to the top portion of the selector valve and then to the airplane's integral tanks. One drain is added to properly drain the fuel return system.

FUEL DISTRIBUTION

Fuel flows by gravity from the two wing tanks through the fuel manifold (aft pickup only), and to a four position selector valve. From the selector valve, fuel flows through the auxiliary fuel pump, the fuel strainer, and to the engine driven fuel pump. A portion of the fuel (approximately 7 GPH) is returned to the wing tank currently selected through the use of the fuel return system. From the engine driven fuel pump, fuel is delivered to the fuel/air control unit on the bottom of the engine. The fuel/air control unit (fuel servo) meters fuel flow in proportion to induction air flow. After passing through the control unit, metered fuel goes to a fuel distribution valve (flow divider) located on the bottom of the engine. From the fuel distribution valve, individual fuel lines are routed to air bleed type injector nozzles located in the intake chamber of each cylinder.

FUEL INDICATING

Fuel quantity is measured by two float type fuel quantity transmitters (one in each tank) and indicated by an electrically operated fuel quantity indicator on the left side of the instrument panel. The gauges are marked in gallons of fuel. An empty tank is indicated by a red line and the number 0. When an indicator shows an empty tank, approximately 2.5 gallons remain in each tank as unusable fuel. The indicators should not be relied upon for accurate readings during skids, slips, or unusual attitudes.

Each fuel tank also incorporates warning circuits which can detect low fuel conditions and erroneous transmitter messages. Anytime fuel in the tank drops below approximately 8 gallons (and remains below this level for more than 60 seconds), the amber LOW FUEL message will flash on the annunciator panel for approximately 10 seconds and then remain steady amber. The annunciator cannot be turned off by the pilot. If the left tank is low, the message will read L LOW FUEL. If the right tank is low, the message will read LOW FUEL R. If both tanks are low, the message will read L LOW FUEL R.

In addition to low fuel annunciation, the warning circuitry is designed to report failures with each transmitter caused by shorts, opens or transmitter resistance which increases over time. If the circuitry detects any one of these conditions, the fuel level indicator needle will go to the OFF position (below the 0 mark on the fuel indicator), and the amber annunciator will illuminate. If the left tank transmitter has failed, the message will read L LOW FUEL. If the right tank transmitter has failed, the message will read LOW FUEL R. If both tanks transmitters have failed, the message will read L LOW FUEL R.

Fuel flow is measured by use of a fuel transducer (flowmeter). Normal operating (green arc) range is 0 to 18 gallons-per-hour with a step at 16 gallons-per-hour.

AUXILIARY FUEL PUMP OPERATION

The auxiliary fuel pump is used primarily for priming the engine before starting. Priming is accomplished through the fuel injection system. The engine may be flooded if the auxiliary FUEL PUMP switch is accidentally placed in the ON position for prolonged periods, with MASTER Switch ON and mixture rich, with the engine stopped. The auxiliary fuel pump is also used for vapor suppression in hot weather. Normally, momentary use will be sufficient for vapor suppression; however, continuous operation is permissible if required. Turning on the auxiliary fuel pump with a normally operating engine driven fuel pump will result in only a very minor enrichment of the mixture.

It is not necessary to operate the auxiliary fuel pump during normal takeoff and landing, since gravity and the engine driven fuel pump will supply adequate fuel flow. In the event of failure of the engine driven

fuel pump, use of the auxiliary fuel pump will provide sufficient fuel to maintain flight at maximum continuous power. Under hot day, high altitude conditions, or conditions during a climb that are conducive to fuel vapor formation, it may be necessary to utilize the auxiliary fuel pump to attain or stabilize the fuel flow required for the type of climb being performed. In this case, turn the auxiliary fuel pump on, and adjust the mixture to the desired fuel flow. If fluctuating fuel flow (greater than 1 GPH) is observed during climb or cruise at high altitudes on hot days, place the auxiliary fuel pump switch in the ON position to clear the fuel system of vapor. The auxiliary fuel pump may be operated continuously in cruise.

FUEL RETURN SYSTEM

A fuel return system was incorporated to improve engine operation during extended idle operation in hot weather environments. The major components of the system include an orifice fitting located in the top of the fuel servo, a dual stack fuel selector and a drain valve assembly. The system is designed to return fuel/vapor back to the main fuel tanks at approximately 7 GPH. The dual stack fuel selector ensures that fuel/vapor returns only to the fuel tank that is selected as the feed tank. For example, if the fuel selector is positioned to use fuel from the left fuel tank, the fuel return system is returning fuel/vapor to the left fuel tank only.

FUEL VENTING

Fuel system venting is essential to system operation. Complete blockage of the fuel venting system will result in decreasing fuel flow and eventual engine stoppage. The fuel venting system consists of an interconnecting vent line between the fuel tanks and check valve equipped overboard vents in each fuel tank. The overboard vents protrude from the bottom surface of the wings behind the wing struts, slightly below the upper attach points of the struts. The fuel filler caps are vacuum vented; the fuel filler cap vents will open and allow air to enter the fuel tanks in case the overboard vents become blocked.

REDUCED TANK CAPACITY

The airplane may be serviced to a reduced capacity to permit heavier cabin loadings. This is accomplished by filling each tank to the bottom edge of the fuel filler indicator tab, thus giving a reduced fuel load of 32.0 gallons usable in each tank or to the line of holes located inside the filler indicator tab, thus giving a reduced fuel load of 37.0 gallons usable in each tank.

FUEL DRAIN VALVES

The fuel system is equipped with drain valves to provide a means for the examination of fuel in the system for contamination and grade. The system should be examined before each flight and after each refueling, by using the sampler cup provided to drain fuel from each wing tank sump and the fuel strainer sump. If any evidence of fuel contamination is found, it must be eliminated in accordance with the Preflight Inspection checklist. If takeoff weight limitations for the next flight permit, the fuel tanks should be filled after each flight to prevent condensation.

Engine Priming

The C182 Skylane isn't fitted with a dedicated priming pump. Instead, to prime the engine, you use the fuel pump and the mixture control to add sufficient fuel into the combustion chamber prior to engine start.

This is done by completing the following actions.

- Auxilliary Fuel Pump – ON.
- Mixture -- SET to FULL RICH (full forward) until stable fuel flow is indicated (usually 3 to 5 seconds), then set to IDLE CUTOFF (full aft) position.
- Auxiliary Fuel Pump – OFF.
- If after these steps have been carried out, the engine continues to fail to start, the Auxilliary Fuel Pump can be used to assist startup.

BRAKE SYSTEM

The airplane has a single-disc, hydraulically actuated brake on each main landing gear wheel. Each brake is connected, by a hydraulic line, to a master cylinder attached to each of the pilot's rudder pedals. The brakes are operated by applying pressure to the top of either the left (pilot's) or right (copilot's) set of rudder pedals, which are interconnected. When the airplane is parked, both main wheel brakes may be set by utilizing the parking brake which is operated by a handle under the left side of the instrument panel. To apply the parking brake, set the brakes with the rudder pedals, pull the handle aft, and rotate it 90° down.

For maximum brake life, keep the brake system properly maintained, and minimize brake usage during taxi operations and landings.

With Accu-Sim, we increase the likelihood of hearing brake noise and squeals as the breaks age. Hearing the occasional squeal is normal, but if your breaks start making noise regularly, bring the plane into the maintenance hangar for a check.

ELECTRICAL SYSTEM AND BATTERY

Accu-Sim installs an authentic period battery into a feature-rich electrical system, thanks to close consultation with our own on-staff electrical engineer and high time pilots. Batteries suffer from reduced capacity as they age, have a limited output (34 amp hours), can overheat if you demand too much from them, and can even load up your entire system if you have a brand new, but dead battery on-line. (ever try to jump start a car with a dead battery and nothing happens? You have to disconnect the dead battery and try again, since the dead battery is stealing all the electricity). The physical laws governing electricity are inexorable as those which govern running water. Our latest and most sophisticated version of Accu-Sim accurately replicates those physical laws and permits you to see the electrical system at work, via the ammeter on your electrical panel and through sounds and behaviour of the various electrically driven systems.

Volts, amps, watts, what does this all mean?

Without getting too technical, the pilot in command must understand the basics of what is happening in the aircraft's electrical system and components. Volts X Amps = watts. If we use a water hose as an analogy, volts would be the water pressure, amps would be the hose width, and watts would be the amount / rate of water coming out the end. You could have, for example, a 120 volt, 1 amp light bulb would be the same brightness as a 12 volt, 10 amp bulb. The high voltage system is sending high pressure down a small pipe, and the low voltage system is sending low pressure down a large pipe, but each putting out the same amount of water (watts).

If you take a huge draw, for example running an electric engine starter, voltage will plummet as the battery struggles to supply this current. Your Ammeter will show the current draw. However, play with your lights, pitot heat, etc. and watch how these little changes affect these systems. Remember, your electrical system has a battery and an engine driven electrical generator. The battery puts out about 24 volts, while the generator puts out a little more (about 28 volts). This allows your generator to not only drive all of the systems, but charge the battery at the same time. Remember, your generator is powered by the engine speed, and it does not reach it's full capacity until about 1,500 RPM. Watch your meters, and you will see and enjoy a genuine electrical system in action.

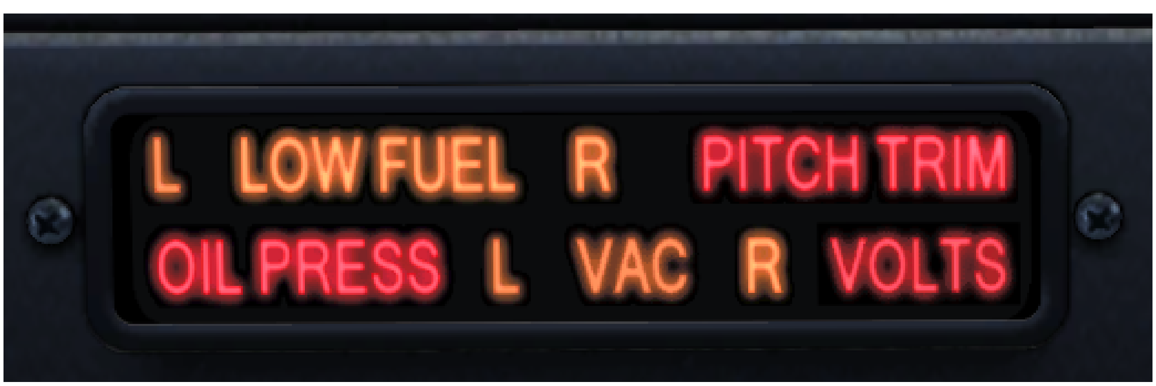
In addition, weather affects a battery's performance. Fortunately, you can always visit your maintenance hangar for a quick charge or replacement. If you use your battery wisely and correctly, it will last a long time.

ELECTRICAL SYSTEM DESCRIPTION

The airplane is equipped with a 28-volt direct current (DC) electrical system. A belt-driven 60 ampere or optional 95 ampere alternator powers the system. A 24-volt main storage battery is located in the tailcone of the airplane. The alternator and main battery are controlled through the MASTER switch found near the top of the pilot's switch panel.

Power is supplied to most electrical circuits through two primary buses (ELECTRICAL BUS 1 and ELECTRICAL BUS 2), with an essential bus and a crossfeed bus connected between the two primary buses to support essential equipment.

The system is equipped with a secondary or standby battery located between the firewall and the instrument panel. The STBY BATT switch controls power to or from the standby battery. The standby battery is available to supply power to the essential bus in the event that alternator and main battery power sources have both failed.



The primary buses are supplied with power whenever the MASTER switch is turned on, and are not affected by starter or external power usage. Each primary bus is also connected to an avionics bus through a circuit breaker and the AVIONICS BUS 1 and BUS 2 switches. Each avionics bus is powered when the MASTER switch and the corresponding AVIONICS switch are in the ON position.

CAUTION: BOTH BUS 1 AND BUS 2 AVIONICS SWITCHES SHOULD BE TURNED OFF TO PREVENT ANY HARMFUL TRANSIENT VOLTAGE FROM DAMAGING THE AVIONICS EQUIPMENT PRIOR TO TURNING THE MASTER SWITCH ON OR OFF, STARTING THE ENGINE OR APPLYING AN EXTERNAL POWER SOURCE.

The airplane includes a power distribution module, located on the left forward side of the firewall, to house all the relays used in the airplane electrical system. The Alternator Control Unit (ACU), main battery current sensor, and the external power connector are also housed within the module.

ANNUNCIATOR PANEL

An annunciator panel (with integral toggle switch) is located above the avionics stack and provides caution (amber) and warning (red) messages for selected portions of the airplane systems. The annunciator is designed to flash messages for approximately 10 seconds to gain the attention of the pilot before changing to steady on. The annunciator panel cannot be turned off by the pilot.

Inputs to the annunciator come from each fuel transmitter, the low oil pressure switch, the vacuum transducers and the alternator control unit (ACU). Individual LED bulbs illuminate each message and may be replaced through the rear of the annunciator. Illumination intensity can be controlled by placing the toggle switch to either the DIM or DAY position.

The annunciator panel can be tested by turning the Master Switch On and holding the annunciator panel switch in the TST position. All amber and red messages will flash until the switch is released.

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

MASTER SWITCH

The master switch is a split rocker type switch labeled MASTER, and is ON in the up position and off in the down position. The right half of the switch, labeled BAT, controls all electrical power to the airplane. The left half, labeled ALT, controls the alternator.

CAUTION: PRIOR TO TURNING THE MASTER SWITCH ON OR OFF, STARTING THE ENGINE OR APPLYING AN EXTERNAL POWER SOURCE, THE AVIONICS POWER SWITCH, LABELED AVIONICS POWER, SHOULD BE TURNED OFF TO PREVENT ANY HARMFUL TRANSIENT VOLTAGE FROM DAMAGING THE AVIONICS EQUIPMENT.

Normally, both sides of the master switch should be used simultaneously; however, the BAT side of the switch could be turned on separately to check equipment while on the ground. To check or use avionics equipment or radios while on the ground, the avionics power switch must also be turned on. The ALT side of the switch, when placed in the off position, removes the alternator from the electrical system. With this switch in the off position, the entire electrical load is placed on the battery. Continued operation with the alternator switch in the off position will reduce battery power low enough to open the battery contactor, remove power from the alternator field, and prevent alternator restart.

AVIONICS MASTER SWITCH

Electrical power for Avionics Bus 1 and Avionics Bus 2 is supplied through Primary Bus 2 and Primary Bus 1, respectively. A rocker switch, located between the primary and avionics buses, controls current flow to the avionics buses. Placing the rocker switch in the up (ON) position supplies power to both buses simultaneously. Placing the switch in the down (OFF) position removes power from both buses. The switch is located on the lower left side of the instrument panel.

NOTE: On some aircraft certified outside the United States, the avionics master switch may be split. They are aligned for independent operation of the buses.

With the switch in the off position, no electrical power will be applied to the avionics equipment, regardless of the position of the master switch or the individual equipment switches. The avionics power switch should be placed in the OFF position prior to turning the master switch on or off, starting the engine, or applying an external power source.

Each avionics bus also incorporates a separate circuit breaker installed between the primary bus and the avionics master switch. In the event of an electrical malfunction, this breaker will trip and take the effected avionics bus off-line.

AMMETER

The ammeter/vacuum gauge is located on the lower left side of the instrument panel. It indicates the amount of current, in amperes, from the alternator to the battery or from the battery to the airplane electrical system. When the engine is operating and the master switch is turned on, the ammeter indicates the charging rate applied to the battery. In the event the alternator is not functioning or the electrical load exceeds the output of the alternator, the ammeter indicates the battery discharge rate.

LOW VOLTAGE ANNUNCIATION

The low voltage warning annunciator is incorporated in the annunciator panel and activates when voltage falls below 24.5 volts. If low voltage is detected, the red annunciation VOLTS will flash for approximately 10 seconds before illuminating steadily. The pilot cannot turn off the annunciator.

NOTE: Illumination of the low voltage annunciator and ammeter discharge indications may occur during low RPM conditions with an electrical load on the system, such as during a low RPM taxi. Under these conditions, the light will go out at higher RPM.

LIGHTING SYSTEMS

EXTERIOR LIGHTING

Exterior lighting consists of navigation lights on the wing tips and top of the rudder, a dual landing/taxi light configuration located in the left wing leading edge, a flashing beacon mounted on top of the vertical fin, and a strobe light on each wing tip. In addition, two courtesy lights are recessed into the lower surface of each wing and provide illumination for each cabin door area.

The exterior courtesy lights (and the rear cabin dome light) are turned on by pressing the rear cabin light switch. Pressing the rear cabin light switch again will extinguish the three lights. The remaining exterior lights are operated by breaker/switches located on the lower left instrument panel. To activate these lights, place switch in the UP position. To deactivate light, place in the DOWN position.

INTERIOR LIGHTING

Interior lighting is controlled by a combination of flood lighting, glareshield lighting, pedestal lighting, panel lighting, and radio lighting. Flood lighting is accomplished using two lights in the front and a single dome light in the rear. All flood lights are contained in the overhead console, and are turned on and off with push type switches located near each light.

Glareshield lighting is accomplished using an LED light recessed into the glareshield. Pedestal lighting consists of hooded lights located above the fuel selector. Panel lighting is accomplished using individual lights mounted in each instrument and gauge.

CABIN HEATING, VENTILATING AND DEFROSTING SYSTEM

The temperature and volume of airflow into the cabin can be regulated by manipulation of the push-pull CABIN HT and CABIN AIR controls. Both controls are the double-button locking type and permit intermediate settings. For cabin ventilation, pull the CABIN AIR knob out.

To raise the air temperature, pull the CABIN HT knob out approximately ¼ to ½ inch for a small amount of cabin heat. Additional heat is available by pulling the knob out farther; maximum heat is available with the CABIN HT knob pulled out and the CABIN AIR knob pushed full in. When no heat is desired in the cabin, the CABIN HT knob is pushed full in.

Front cabin heat and ventilating air is supplied by outlet holes spaced across a cabin manifold just forward of the pilot's and copilot's feet. Rear cabin heat and air is supplied by two ducts from the manifold, one extending down each side of the cabin to an outlet just aft of the rudder pedals at floor level.

Windshield defrost air is also supplied by two ducts leading from the cabin manifold to defroster outlets near the lower edge of the windshield. Two knobs control sliding valves in either defroster outlet to permit regulation of defroster airflow. Separate adjustable ventilators supply additional air; one near each upper corner of the windshield supplies air for the pilot and copilot, and two ventilators are available for the rear cabin area to supply air to the rear seat passengers. Additionally, there are ventilators located on the forward cabin sidewall area just below the windshield sill area.

PITOT-STATIC SYSTEM AND INSTRUMENTS

The pitot-static system supplies ram air pressure to the airspeed indicator and static pressure to the airspeed indicator, vertical speed indicator and altimeter. The system is composed of a heated pitot tube mounted on the lower surface of the left wing, an external static port on the lower left side of the forward fuselage, and the associated plumbing necessary to connect

the instruments to the sources. The heated pitot system consists of a heating element in the pitot tube, a 10-amp switch/breaker labeled PITOT HEAT, and associated wiring. The switch/breaker is located on the lower left side of the instrument panel. When the pitot heat switch is turned on, the element in the pitot tube is heated electrically to maintain proper operation in possible icing conditions. A static pressure alternate source valve is "located adjacent to the throttle, and can be used if the external static source is malfunctioning. This valve supplies static pressure from inside the cabin instead of the external static port. If erroneous instrument readings are suspected due to water or ice in the pressure line going to the standard external static pressure source, the alternate static source valve should be pulled on. Pressures within the cabin will vary with open heater/vents and windows.

AIRSPEED INDICATOR

The airspeed indicator is calibrated in KIAS. It incorporates a true airspeed window which allows true airspeed (ktas) to be read off the face of the dial. In addition, the indicator incorporates a window at the twelve o'clock position. The window displays true airspeed, and the window at the twelve o'clock position displays pressure altitude overlayed with a temperature scale. Limitation and range markings (in KIAS) include the white arc (41 to 100 KIAS), green arc (51 to 140 KIAS), yellow arc (140 to 175 KIAS), and a red line (175 KIAS). To find true airspeed, first determine pressure altitude and outside air temperature. Using this data, rotate the lower left knob until pressure altitude aligns with outside air temperature in the twelve o'clock window. True airspeed (corrected for pressure and temperature) can now be read in the lower window.

VERTICAL SPEED INDICATOR

The vertical speed indicator depicts airplane rate of climb or descent in feet per minute. The pointer is actuated by atmospheric pressure changes resulting from changes of altitude as supplied by the static source.

ALTIMETER

Airplane altitude is depicted by a barometric type altimeter. A knob near the lower left portion of the indicator provides adjustment of the instrument's barometric scale to the current altimeter setting.

VACUUM SYSTEM AND INSTRUMENTS

The vacuum system provides suction necessary to operate the attitude indicator and the directional indicator. The system consists of two engine-driven vacuum pumps, two pressure switches for measuring vacuum available through each pump, a vacuum relief valve, a vacuum system air filter, vacuum operated instruments, a suction gauge, low vacuum warning on the annunciator, and a manifold with check valves to allow for normal vacuum system operation if one of the vacuum pumps should fail.

ATTITUDE INDICATOR

The attitude indicator is a vacuum air-driven gyro that gives a visual indication of flight attitude. Bank attitude is presented by a pointer at the top of the indicator relative to the bank scale which has index marks at 10°, 20°, 30°, 60°, and 90° either side of the center mark. Pitch and roll attitudes are presented by a miniature airplane superimposed over a symbolic horizon area divided into two sections by a white horizon bar. The upper "blue sky" area and the lower "ground" area have pitch reference lines useful for pitch attitude control. A knob at the bottom of the instrument is provided for in-flight adjustment of the symbolic airplane to the horizon bar for a more accurate flight attitude indication.

DIRECTIONAL INDICATOR

The directional indicator is a vacuum air-driven gyro that displays airplane heading on a compass card in relation to a fixed simulated airplane image and index. The indicator will precess slightly over a period of time. Therefore, the compass card should be set with the magnetic compass just prior to takeoff, and readjusted as required throughout the flight. A knob on the lower left edge of the instrument is used to adjust the compass card to correct for precession. A knob on the lower right edge of the instrument is used to move the heading bug.

VACUUM INDICATOR

The vacuum indicator is part of the vacuum/amp indicator, located on the lower left corner of the instrument panel. It is calibrated in inches of mercury and indicates vacuum air available for operation of the attitude and directional indicators. The desired vacuum range is 4.5 to 5.5 inches of mercury. Normally, a vacuum reading out of this range may indicate a system malfunction or improper adjustment, and in this case, the indicators should not be considered reliable. However, due to lower atmospheric pressures at higher altitudes, the vacuum indicator may indicate as low as 4.5 in. Hg. at 15,000 feet and still be adequate for normal system operation.

LOW VACUUM ANNUNCIATION

Each engine-driven vacuum pump is plumbed to a common manifold, located forward of the firewall. From the tee, a single line runs into the cabin to operate the various vacuum system instruments. This tee contains check valves to prevent back flow into a pump if it fails. Transducers are located just upstream of the tee and measure vacuum output of each pump. If output of the left pump falls below 3.0 in. Hg., the amber L VAC message will flash on the annunciator panel for approximately 10 seconds before turning steady on. If output of the right pump falls below 3.0 in. Hg., the amber VAC R message will flash on the annunciator panel for approximately 10 seconds before turning steady on. If output of both pumps falls below 3.0 in. Hg., the amber L VAC R message will flash on the annunciator panel for approximately 10 seconds before turning steady on.

CLOCK / O.A.T. INDICATOR

An integrated clock / O.A.T. / voltmeter is installed in the upper left side of the instrument panel as standard equipment.

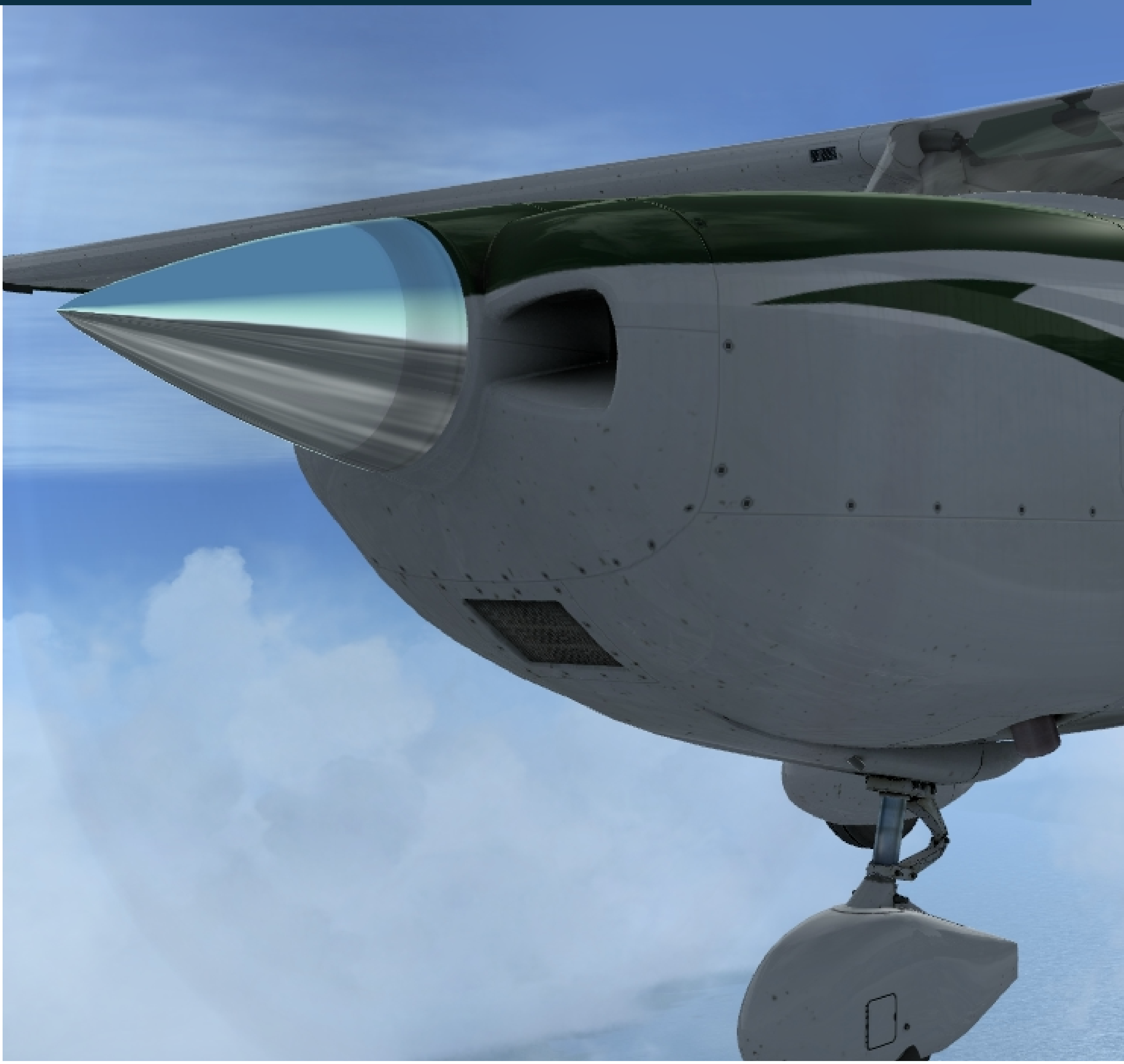
STALL WARNING SYSTEM

The airplane is equipped with a vane-type stall warning system consisting of an inlet in the leading edge of the left wing, which is electrically connected to a stall warning horn located in the headliner above the left cabin door. A 5-amp push-to-reset circuit breaker labeled WARN, on the left side of the circuit breaker panel, protects the stall warning system. The vane in the wing senses the change in airflow over the wing, and operates the warning horn at airspeeds between 5 and 10 knots above the stall in all configurations.

The airplane has a heated stall warning system, the vane and sensor unit in the wing leading edge is equipped with a heating element. The heated part of the system is operated by the PITOT HEAT switch, and is protected by the PITOT HEAT circuit breaker.

The stall warning system should be checked during the preflight inspection by momentarily turning on the MASTER switch and actuating the vane in the wing. The system is operational if the warning horn sounds as the vane is pushed upward.

AIRPLANE HANDLING, SERVICE + MAINTENANCE



THIS SECTION CONTAINS FACTORY recommended procedures for proper ground handling and routine care and servicing of your airplane. It also identifies certain inspection and maintenance requirements which must be followed if your airplane is to retain that new plane performance and dependability. It is wise to follow a planned schedule of lubrication and preventive maintenance based on climatic and flying conditions encountered in your locality. Keep in touch with your local Cessna Service Station and take advantage of their knowledge and experience. Your Cessna Service Station knows your airplane and how to maintain it, and will remind you when lubrications and oil changes are necessary, as well as other seasonal and periodic services. The airplane should be regularly inspected and maintained in accordance with information found in the airplane maintenance manual and in company issued service bulletins and service newsletters. All service bulletins pertaining to the aircraft by serial number should be accomplished and the airplane should receive repetitive and required inspections. Cessna does not condone modifications, whether by Supplemental Type Certificate or otherwise, unless these certificates are held and/or approved by Cessna. Other modifications may void warranties on the airplane since Cessna has no way of knowing the full effect on the overall airplane. Operation of an airplane that has been modified may be a risk to the occupants, and operating procedures and performance data set forth in the operating handbook may no longer be considered accurate for the modified airplane.

FUEL CONTAMINATION

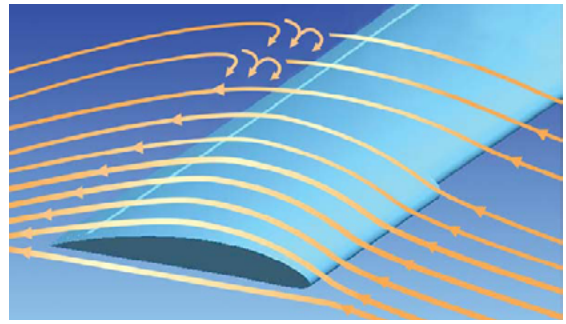
Fuel contamination is usually the result of foreign material present in the fuel system, and may consist of water, rust, sand, dirt, microbes or bacterial growth. In addition, additives that are not compatible with fuel or fuel system components can cause the fuel to become contaminated. Before each flight and after each refueling, use a clear sampler cup and drain at least a cupful of fuel from each fuel tank drain location and from the fuel strainer quick drain valve to determine if contaminants are present, and to ensure the airplane has been fueled with the proper grade of fuel. If contamination is detected, drain all fuel drain points including the fuel reservoir and fuel selector quick drain valves and then gently rock the wings and lower the tail to the ground to move any additional contaminants to the sampling points. Take repeated samples from all fuel drain points until all contamination has been removed. If, after repeated sampling, evidence of contamination still exists, the airplane should not be flown. Tanks should be drained and system purged by qualified maintenance personnel. All evidence of contamination must be removed before further flight. If the airplane has been serviced with the improper fuel grade, defuel completely and refuel with the correct grade. Do not fly the airplane with contaminated or unapproved fuel. In addition, Owners/Operators who are not acquainted with a particular fixed base operator should be assured that the fuel supply has been checked for contamination and is properly filtered before allowing the airplane to be serviced. Fuel tanks should be kept full between flights, provided weight and balance considerations will permit, to reduce the possibility of water condensing on the walls of partially filled tanks. To further reduce the possibility of contaminated fuel, routine maintenance of the fuel system should be performed in accordance with the airplane Maintenance Manual. Only the proper fuel, as recommended in this handbook, should be used, and fuel additives should not be used unless approved by Cessna and the Federal Aviation Administration.

THE AIRFOIL: HOW A WING CREATES LIFT

Before you learn about how different propellers work, first you must understand the basics of the common airfoil, which is the reason why a wing creates lift, and in this case, why a propeller creates thrust.

The Bernoulli Theory
This has been the traditional theory of why an airfold creates lift:

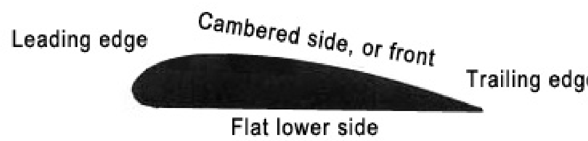
Look at the image to the right which shows you how the shape of an airfoil splits the oncoming air. The air above is forced to travel further than the air at the bottom, essentially stretching the air and creating a lower pressure, or vacuum. The wing is basically sucked up, into this lower pressure. The faster the speed, the greater the lift.



The Newton Theory
As the air travels across the airfoil's upper and lower surfaces, lift is created by shoving the air down with great force at its trailing edge, and to some degree, the Newtonian force of opposite and equal reaction apply.

What we do know (and what the pilot needs to know)
The airfoil is essentially an air diverter and the lift is the reaction to the diverted air. Regardless of what role each theory plays, an airfoil's lift is dependent upon its shape, the speed at which it is traveling through the air, and its angle to the oncoming air (angle of attack).

Look at the cross section of a propeller blade. Essentially, the same process creates lift.

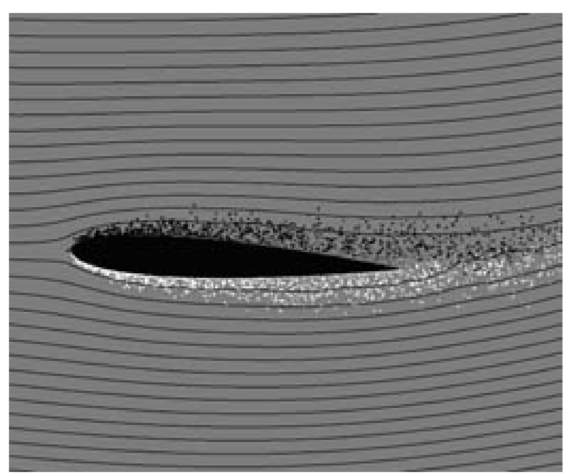


Cross section of a propeller blade

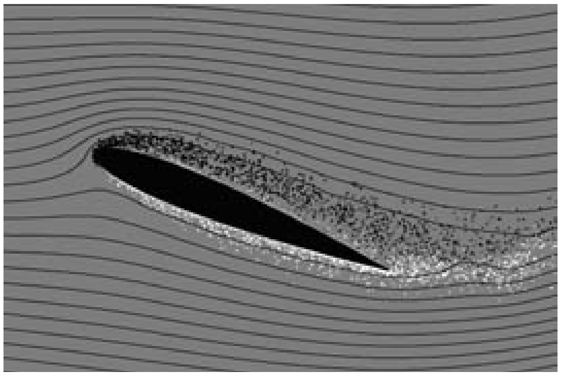
Below are some graphical representations of an airfoil travelling though the air in various conditions:

LEVEL FLIGHT

A wing creating moderate lift. Air vortices (lines) stay close to the wing.

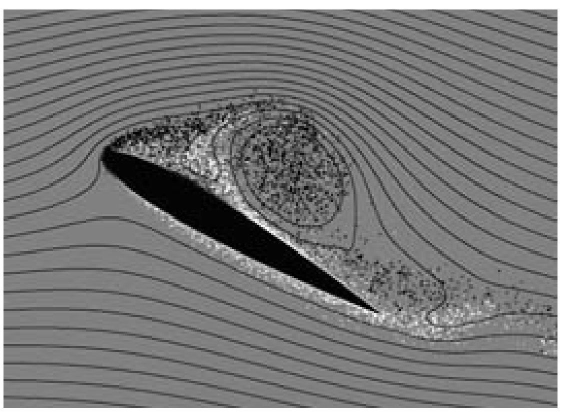


CLIMB
Wing creating significant lift force. Air vortices still close to the wing.



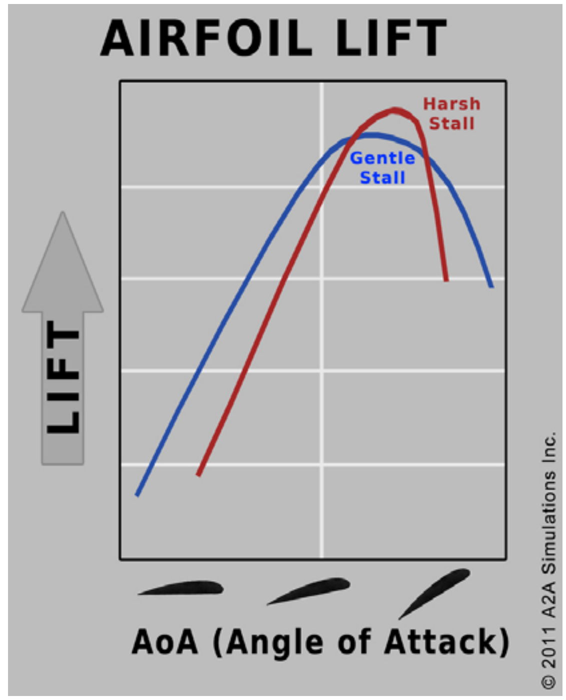
WHAT IS A STALL?
In order for a wing to produce efficient lift, the air must flow completely around the leading (front) edge of the wing, following the contours of the wing. At too large an angle of attack, the air cannot contour the wing. When this happens, the wing is in a "stall."

Typically, stalls in aircraft occur when an airplane loses too much airspeed to create a sufficient amount of lift. A typical stall exercise would be to put your aircraft into a climb, cut the throttle, and try and maintain the climb as long as possible. You will have to gradually pull back harder on the stick to maintain your climb pitch and as speed decreases, the angle of attack increases. At some point, the angle of attack will become so great, that the wing will stall (the nose will drop).



STALL
The angle of attack has become too large. The boundary layer vortices have separated from the top surface of the wing and the incoming flow no longer bends completely around the leading edge. The wing is stalled, not only creating little lift, but significant drag.

Can a propeller stall?
What do you think? More on this below.



LIFT VS ANGLE OF ATTACK
Every airfoil has an optimum angle at which it attacks the air (called angle of attack, or AoA), where lift is at it's peak. The lift typically starts when the wing is level, and increases until the wing reaches its optimum angle, lets say 15-25 degrees, then as it passes this point, the lift drops off. Some wings have a gentle drop, others can actually be so harsh, as your angle of attack increases past this critical point, the lift drops off like a cliff. Once you are past this point of lift and the angle is so high, the air is just being plowed around in circles, creating almost no lift but plenty of drag. This is what you experience when you stall an aircraft. The buffeting or shaking of the aircraft at this stall position is actually the turbulent air, created by your stalling wing, passing over your rear stabilizer, thus shaking the aircraft. This shaking can sometimes become so violent, you can pop rivets and damage your airframe. You quickly learn to back off your stick (or yoke) when you feel those shudders approaching.

Notice in the diagram to the right, how the airfoil creates more lift as the angle of attack increases. Ideally, your wing (or propeller) will spend most of it's time moving along the left hand side of this curve, and avoid passing over the edge. A general aviation plane that comes to mind is the Piper Cherokee. An older version has what we call a "Hershy bar wing" because it is uniform from the root to the tip, just like an Hershy chocolate bar.   Later, Piper introduced the tapered wing, which stalled more gradually, across the wing. The Hershy bar wing has an abrupt stall, whereas the tapered wing has a gentle stall.

A propeller is basically a wing except that instead of relying on incoming air for lift, it is spinning around to create lift, it is perpendicular to the ground, creating a backwards push of air, or thrust. Just remember, whether a propeller is a fixed pitch, variable pitch, or constant speed, it is always attacking a variable, incoming air, and lives within this lift curve.

FROM STALL TO FULL POWER

With brakes on and idling, the angle at which the prop attacks the still air, especially closer to the propeller hub, is almost always too great for the prop to be creating much lift. The prop is mostly behaving like a brake as it slams it's side into the air. In reality, the prop is creating very little lift while the plane is not moving. This effect is known as prop stall, and is part of the Accu-Sim prop physics suite.

Once done with your power check, prepare for takeoff. Once you begin your takeoff run, you may notice the aircraft starts to pull harder after you start rolling forward. This is the propeller starting to get its proper "bite" into the air, as the propeller blades come out of their stalled, turbulent state and enter their comfortable high lift angles of attack it was designed for. There are also other good physics going on during all of these phases of flight, that we will just let you experience for the first time yourself.

PROP OVERSPEED

With a constant-speed propeller, a power descent can be made without overspeeding the engine. The system compensates for the increased airspeed of the descent by increasing the propeller blade angles. If the descent is too rapid, or is being made from a high altitude, the maximum blade angle limit of the blades is not sufficient to hold the rpm constant. When this occurs, the rpm is responsive to any change in throttle setting.

Any overspeed will require a prop inspection. Any overspeed greater than 15% of redline (2760 rpm) will require that contact be made with the manufacturer (McCauley Propeller Systems) to determine the prop's airworthiness.

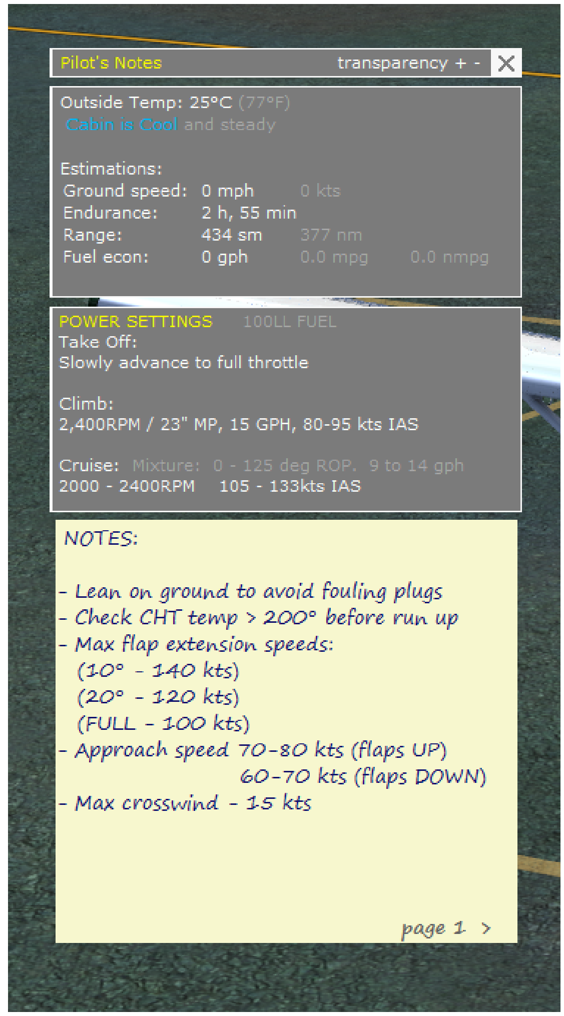
2D PANELS

The 2D panels are there to provide the extra functionality needed when there is so much additional information available to you, the pilot.

Each 2D panel is accessed by the key-press combination in parentheses after the 2D panel title.

Pilot's Notes (Shift 2)

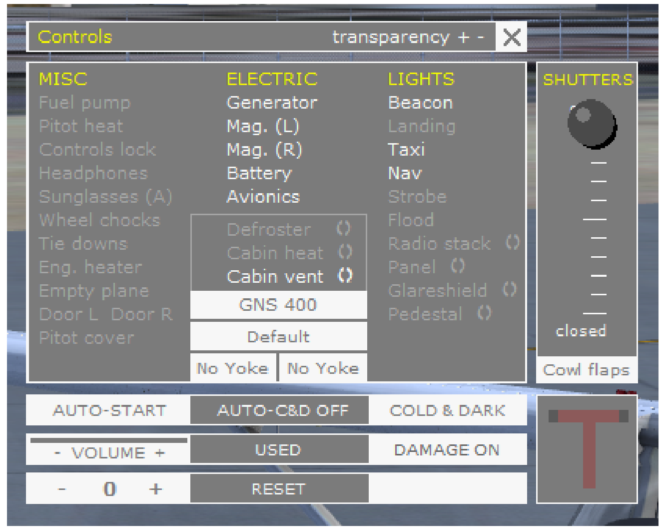
- Outside Temp: is the ambient temperature outside the aircraft.
- Watch Engine Temps: this warning will display if your engine temperature is nearing danger limits. Corrective action should be carried out immediately if this warning appears.
- Cabin Temperature: displays how comfortable the temperature of the cabin feels.
- Ground Speed: this is your speed in relation to the ground in miles/hour and knots.
- Endurance: this figure tells you approximately how long you could remain in powered flight before running out of fuel. This figure will update throughout your flight, and as such you should take into account that during a climb phase, the endurance will be less than once the aircraft is settled in a cruise configuration.
- Range: given in statute (sm) and nautical miles (nm), this figure will give you an approximation of your maximum range under current fuel consumption and airspeed conditions. Again, this figure will change depending on your flight phase.
- Fuel Economy: is the current fuel burn rate given in gallons/hour (gph), miles/gallon (mpg) and nautical miles/gallon (nmpg).
- Power Settings: this represents your clipboard, showing you important information for the correct settings for take off, climb and cruise configurations.
- Notes: these are a set of pages (accessed by the small arrow to the right of the page number) that include information such as actions to be carried out when first entering the cabin, to landing checks.

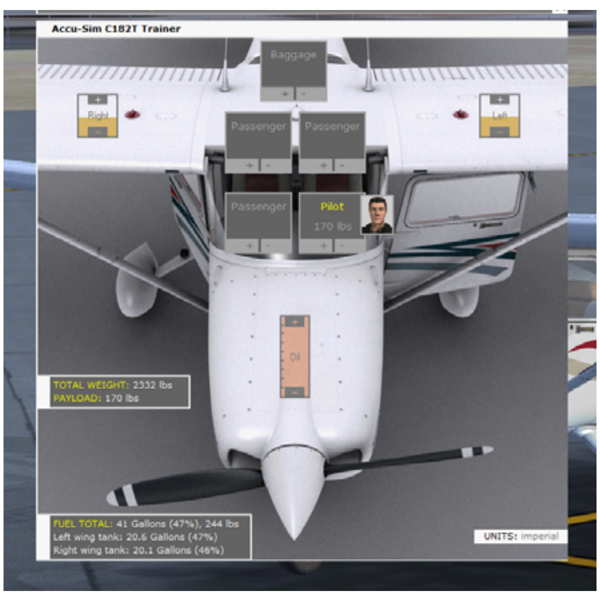


Controls (Shift 3)
Initially designed to provide a means to perform various in cockpit actions whilst viewing the aircraft from an external viewpoint, this control panel now provides quick access to a number of different commands.

From this panel, you can:

- Remove the pilot figure from the external view (only available whilst the engine is not running). Note the visual change in the aircraft balance when you remove the pilot.
- Control electrical systems such as the generator or magnetos.
- Toggle aircraft lighting, both internal and external.
- Change the GPS system installed in your aircraft, from a bracket mounted handheld unit, to panel mounted units, or no GPS installed at all.
- Set whether you want the aircraft to already be in a Cold and Dark state when you first enter it.
- Have your aircraft switch to a “Used” state, where some aircraft components will immediately show signs of wear. Check your maintenance hangar before you go flying, so that you’re aware of the systems and components that you’ll need to keep an eye on.
- Turn Accusim damage on and off.
- Toggle between conventional DG and KI 525A HSI.





Payload and Fuel Manager (Shift 4)
The payload and fuel manager not only gives you an overview of your current payload, fuel and oil quantities, it is also an interactive loading screen, where you can:

- Add and remove passengers and baggage.
- Increase or decrease pilot, passenger and baggage weights.
- Add or remove oil in the reservoir, and change the oil viscosity depending on seasonal changes.
- Add or remove fuel from the wing tanks.
- Change between viewing weights and measures in imperial or metric format.
- View, at a glance, total aircraft weight, payload weight, and total fuel quantities.

Pilot's Map (Shift 5)
The pilot's map gives full and easy access to information that may be found on real maps, and allows this information to be accessed from the cockpit, as opposed to using the default map via the drop-down menus.

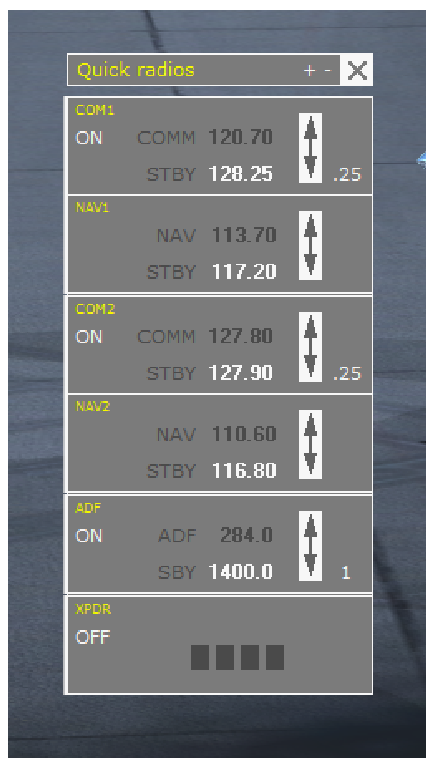
The accompanying panel to the map allows you to select what information you want to have displayed on the map, from a compass rose to low altitude airways.

Also note that some of the button selections have an increasing amount of information presented with each subsequent button press.

For example, the **APT** (Airport) button will show the following information:

- **APT 1:** Airport ID.
- **APT 2:** Airport name.
- **APT 3:** Airport elevation.
- **APT 4:** Airport radio frequencies.

Quick RAdios (Shift 6)
This small popup panel provides input for your virtual cockpit radios but in a simplified and easy to use manner. This popup features all the amenities of the actual radios but in a singular unit which allows you to control your communication, navigation, ADF and transponder radios from a single source.



Maintenance Hangar (Shift 7)
The maintenance hangar is where you can review the current state of your aircraft and its major systems. It is one of the core elements to visualizing Accusim at work.

With the invaluable assistance of your local aircraft maintenance engineer/technician, a.k.a "grease monkey", you will be able to see a full and in-depth report stating the following:

- A summary of your airframe, engine and propeller installed.
- Total airframe hours, and engine hours since the last major overhaul.
- General condition of the engine.
- Important notes provided by the ground crew.

From the maintenance hangar, you can also carry out a complete overhaul, by clicking the **COMPLETE OVERHAUL** button in the bottom right corner. This will overhaul the engine and replace any parts that are showing signs of wear or damage, with new or re-conditioned parts.

In order to fix any issues the mechanic has flagged up, we need to inspect the engine in greater detail. By left clicking the "CHECK ENGINE" text on the engine cover, it will open the following window.

COLOUR CODES:

- GREEN: OK
- YELLOW: WATCH
- RED: MUST FIX OR REPLACE

Heavy wear or a component failure will be shown in red, and these components must be replaced.

We can choose to continue flying with the worn components, but extra care should be used and a close eye kept on those systems/components.

Any component with a yellow highlight is worn, but not unserviceable, so do not have to be replaced.

Compression Test
At the lower right hand corner is a **"COMPRESSION TEST"** button, which will tell your mechanic to run a high pressure differential compression test on the engine cylinders.

This is done by compressed air being applied through a regulator gauge to the tester in the cylinder. The gauge would show the total pressure being applied to the cylinder.

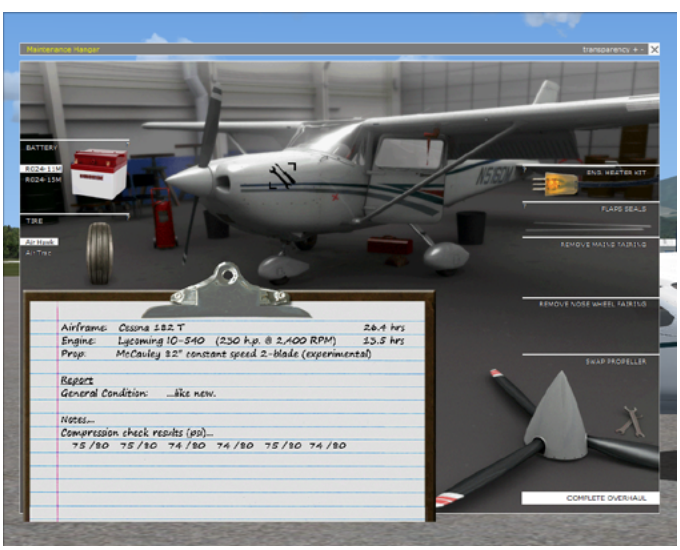
The compressed air would then pass through a calibrated restrictor and to the cylinder pressure gauge. This gauge would show the actual air pressure within the cylinder.

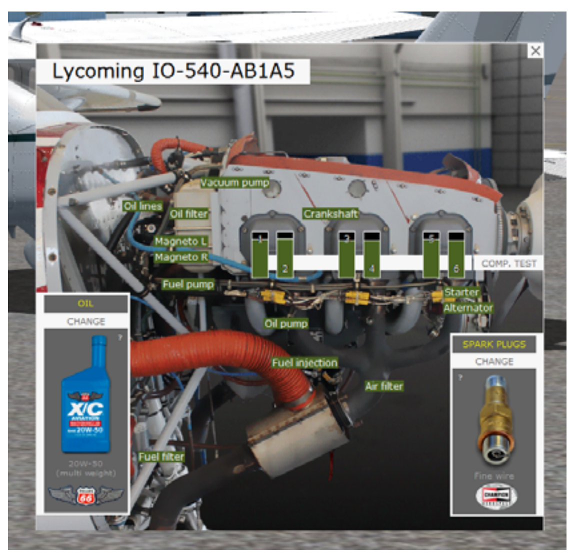
Any difference in pressure between the two gauges would indicate a leak of air past the engine components, whether that is the valves, piston rings, or even a crack in the cylinder wall itself.

The readings that your mechanic presents to you in the "Compression Test Results" in the notes section, will be annotated with the actual amount of pressure read in the cylinder over the actual pressure that was applied to the cylinder through the regulator.

Low compression on a cylinder isn't necessarily a terrible thing, because as the engine picks up in speed, the worn cylinder becomes productive. It is mostly noticed at lower R.P.M.'s where the cylinder may have trouble firing, and also a marked increase in oil consumption may also occur (sometimes with an accompanying blue smoke out of that cylinder during flight).

However, note that this is a reading of the general condition of the cylinders, and lower condition does bring additional risks of failure, or even engine fires.





Pre-Flight Inspection (Shift 8)

The Pre-Flight Inspection is another advancement in bringing real life standard operating procedures into P3D.

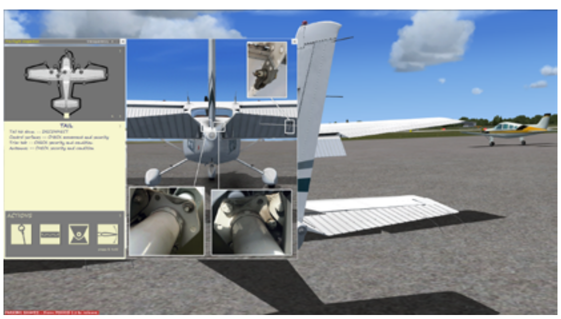
The inspection system is done in such a way as to emulate making your walkaround inspection prior to flight.

There are 19 separate check sheets which are accessed by clicking the arrows in the bottom right corner of the aircraft top-down view window.

As you select the next check sheet, you will automatically be moved to the relevant view around the aircraft.

It's not just a case of clicking the next check sheet over and over again however, as there are actions to be carried out and visual checks to be made in order to complete the pre-flight correctly. If you miss something, maybe the landing light lens cover on the leading edge is smashed, expect to be notified by your mechanic in the Maintenance Hangar, as his sharp eye will pick up anything you miss.

The checklist itself shows an overview of the aircraft, with your walkaround route in black, and dots to highlight the areas where subsequent checks will be carried out.



The check list starts with actions to be carried out in the cockpit, prior to your walkaround.

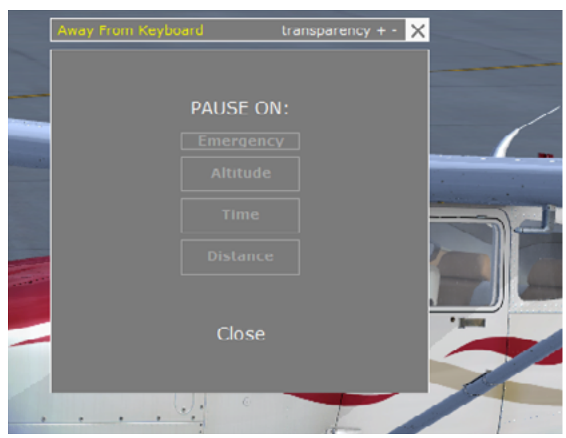
Ensure that the checklist is carried out correctly, as checks and actions missed here, will prevent you from carrying out the proper checks during your walkaround.

The first of the external checks covers the tail area. The checklist now has an additional bottom section in which specific actions can be carried out, or additional views can be accessed as a reference to what to look out for.

By left clicking on an action button, it will either perform an action, i.e. remove the tail tie down, or it will bring up a reference picture. In the example below, we're looking at the elevator hinges.

As part of the walkaround, checking the fuel tank sump quick drain valves is an extremely important check. If water enters the engine, expect a brief interlude of coughing and spluttering, quickly followed by the sound of silence.

The oil dipstick is not only essential in gauging the total oil quantity, but also the condition of the oil. As you put hours on your engine, expect the oil to become darker due to suspended particulates that are too fine to be trapped by the filter. The oil also goes through chemical changes, which over time means that the oil isn't as capable of protecting your engine as it was when new.



Pause Control (shift 9)

The pause controls are made available for those times when you need to be away from the simulation.

By left clicking the various boxes, you will turn that pause command on, and for the Altitude, Time and Distance boxes, a plus and minus arrow allow you to change the values for when the pause command will be issued.

If more than one box is switched on, the first trigger to be reached will pause the simulation.

INPUT CONFIGURATOR

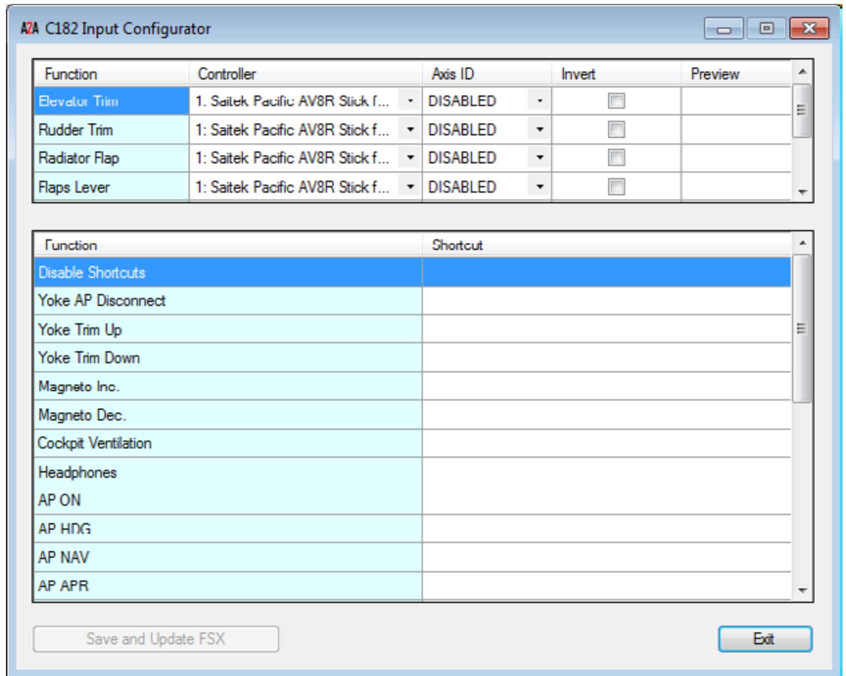
The Input Configurator allows users to assign keyboard or joystick mappings to many custom functions that can't be found in P3D controls assignments

menu. It can be found in the A2A/C182/ Tools folder inside your P3D installation directory.

The upper table is the axis assignment menu. From the drop down list, select joystick and axis you want to assign to each function and verify its operation in the 'preview' column. Mark the 'invert' check box if needed. The lower table is the shortcuts menu. Hover over a function name to bring up a tooltip with additional information.

To make a new shortcut, double click on a selected row to bring up the assignment window. Then press keyboard key or joystick button you want to assign to this function. For keyboard it's also possible to use modifier keys (Ctrl, Shift, Alt).

When done with the assignments, press "Save and update P3D" button. This will instantly update shortcuts for the aircraft. There is no need to restart P3D or even reset your flight for the changes to take effect, you can adjust shortcuts on the fly.



AIRCRAFT CONFIGURATOR

The Aircraft Configurator for Accu-Sim C182 Skylane enables the user to choose from:

1. Various 3rd party GPS systems (RXP, Flight 1, Mindstar, or Stock)
2. Runway illuminating lights or default lights.

Technically, this utility manages the panel.cfg and model.cfg files, so the user doesn't need to manually edit these files.

While the GPS can be changed with or without a running simulation (FSX or Prepar3D), the Landing Lights change takes effect in a next flight of the C182.

ACCU-SIM AND THE C182 SKYLANE

ACCU-SIM IS A2A SIMULATIONS' GROWING FLIGHT SIMULATION engine, which is now connectable to other host simulations. In this case, we have attached our Accu-Sim C182 Skylane to Lockheed Martin Prepar3D to provide the maximum amount of realism and immersion possible.

WHAT IS THE PHILOSOPHY BEHIND ACCU-SIM?

Pilots will tell you that no two aircraft are the same. Even taking the same aircraft up from the same airport to the same location will result in a different experience. For example, you may notice one day your engine is running a bit hotter than usual and you might just open your cowl flaps a bit more and be on your way, or maybe this is a sign of something more serious developing under the hood. Regardless, you expect these things to occur in a simulation just as they do in life. This is Accu-Sim, where no two flights are ever the same.

Realism does not mean having a difficult time with your flying. While Accu-Sim is created by pilots, it is built for everyone. This means everything from having a professional crew there to help you manage the systems, to an intuitive layout, or just the ability to turn the system on or off with a single switch. However, if Accu-Sim is enabled and the needles are in the red, there will be consequences. It is no longer just an aircraft, it's a simulation.

ACTIONS LEAD TO CONSEQUENCES

Your A2A Simulations Accu-Sim aircraft is quite complete with full system modeling and flying an aircraft such as this requires constant attention to the systems. The infinite changing conditions around you and your aircraft have impact on these systems. As systems operate both inside and outside their limitations, they behave differently. For example, the temperature of the air that enters your carburetor has a direct impact on the power your engine can produce. Pushing an engine too hard may produce just slight damage that you, as a pilot, may see as it just not running quite as good as it was on a previous flight. You may run an engine so hot, that it catches fire. However, it may not catch fire; it may just quit, or may not run smoothly. This is Accu-Sim – it's both the realism of all of these systems working in harmony, and all the subtle, and sometimes not so subtle, unpredictability of it all. The end result is when flying in an Accu-Sim powered aircraft, it just feels real enough that you can almost smell the avgas.

YOUR AIRCRAFT TALKS

We have gone to great lengths to bring the internal physics of the airframe, engine, and systems to life. Now, when the engine coughs, you can hear it and see a puff of smoke. If you push the engine too hard, you can also hear signs that this is happening. Just like an actual pilot, you will get to know the sounds of your aircraft, from the tires scrubbing on landing to the stresses of the airframe to the canopy that is cracked opened.

BE PREPARED – STAY OUT OF TROUBLE

The key to successfully operating almost any aircraft is to stay ahead of the curve and on top of things. Aircraft are not like automobiles, in the sense that weight plays a key role in the creation of every component. So, almost every system on your aircraft is created to be just strong enough to give you, the pilot, enough margin of error to operate safely, but these margins are smaller than those you find in an automobile. So, piloting an aircraft requires both precision and respect of the machine you are managing.

It is important that you always keep an eye on your oil pressure and engine temperature gauges. On cold engine starts, the oil is thick and until it reaches a proper operating temperature, this thick oil results in much higher than normal oil temperatures. In extreme cold, once the engine is started, watch that oil pressure gauge and idle the engine as low as possible, keeping the oil pressure under 120psi.

Key Things to Keep Engine Temperatures in Check

- Get off the ground as soon as possible. Prolonged idling and taxiing can overheat your engine.
- Reduce power immediately after takeoff to climb power

PERSISTENT AIRCRAFT

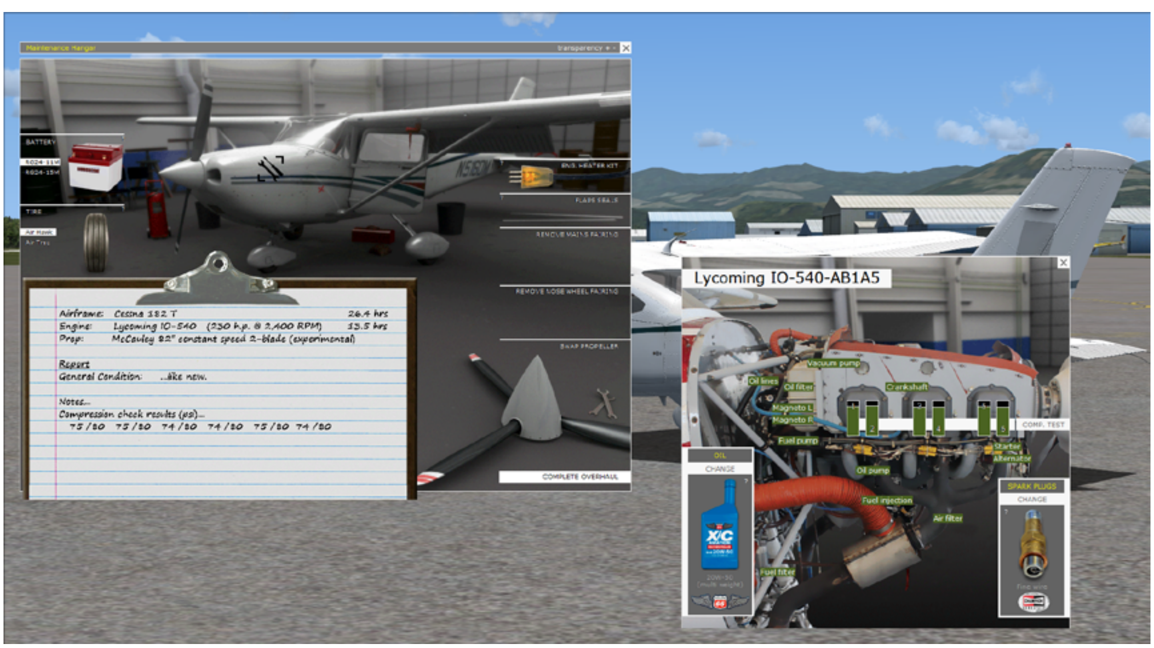
Every time you load up your Accu-Sim C182 Skylane, you will be flying the continuation of the last aircraft which includes fuel, oil, coolant levels along with all of your system conditions. So be aware, no longer will your aircraft load with full fuel every time, it will load with the same amount of fuel you left off when you quit your last flight. You will learn the easy or the hard way to make, at the very least, some basic checks on your systems before jumping in and taking off, just like a real aircraft owner.

Additionally, in each flight things will sometimes be different. The gauges and systems will never be exactly the same. There are just too many moving parts, variables, changes, etc., that continuously alter the condition of the airplane, its engine and its systems.

NOTE: Signs of a damaged engine may be lower RPM (due to increased friction), or possibly hotter engine temperatures.

SOUNDS GENERATED BY PHYSICS

Lockheed Martin Prepar3D, like any piece of software, has its limitations. Accu-Sim breaks this open by augmenting the sound system with our own, adding



sounds to provide the most believable and immersive flying experience possible. The sound system is massive in this Accu-Sim C182 Skylane and includes engine sputter / spits, bumps and jolts, body creaks, engine detonation, runway thumps, gear doors and flaps, dynamic touchdowns, authentic simulation of air including buffeting, shaking, canopy, broken flaps, jammed gear, oxygen sounds, primer, and almost every single switch or lever in the cockpit is modelled. Most of these sounds were recorded from the actual aircraft and this sound environment just breaks open an entirely new world. However, as you can see, this is not just for entertainment purposes; proper sound is critical to creating an authentic and believable flying experience. Know that when you hear something, it is being driven by actual system physics and not being triggered when a certain condition is met. There is a big difference, and to the simulation pilot, you can just feel it.

GAUGE PHYSICS

Each gauge has mechanics that allow it to work. Some gauges run off of engine suction, gyros, air pressure, or mechanical means. The RPM gauge may wander because of the slack in the mechanics, or the gyro gauge may fluctuate when starting the motor, or the gauge needles may vibrate with the motor or jolt on a hard landing or turbulent buffet.

The gauges are the windows into your aircraft's systems and therefore Accu-Sim requires these to behave authentically.

LANDINGS

Bumps, squeaks, rattles, and stress all happens in an aircraft, just when it is taxiing around the ground. Now take that huge piece of lightweight metal and slam it on the pavement. It's a lot to ask of your landing gear. Aircraft engineer's don't design the landing gear any more rugged than they have too. So treat it with kid gloves on your final approach. Kiss the pavement. Anything more is just asking too much from your aircraft.

Accu-Sim watches your landings, and the moment your wheels hit the pavement, you will hear the appropriate sounds (thanks to the new sound engine capabilities). Slam it on the ground and you may hear metal crunching, or just kiss the pavement perfectly and hear just a nice chirp or scrub of the wheels. This landing system part of Accu-Sim makes every landing challenging and fun.

YOUR TURN TO FLY SO ENJOY

Accu-Sim is about maximizing the joy of flight. We at A2A Simulations are passionate about aviation, and are proud to be the makers of both the A2A Simulations Accu-Sim C182 Skylane, and its accompanying Accu-Sim expansion pack. Please feel free to email us, post on our forums, or let us know what you think. Sharing this passion with you is what makes us happy.

CREDITS

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VERY SPECIAL THANKS TO:
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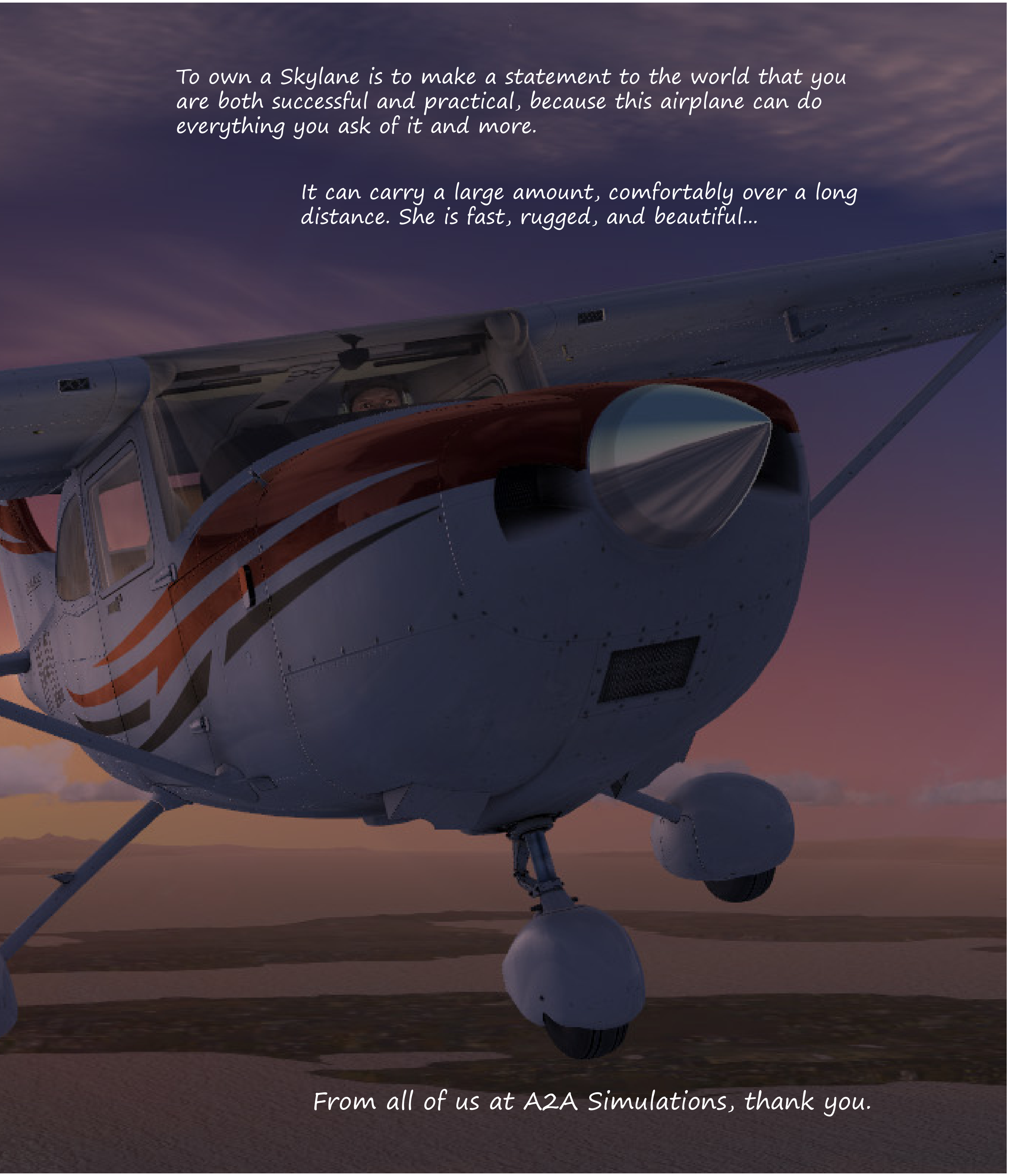

To own a Skylane is to make a statement to the world that you are both successful and practical, because this airplane can do everything you ask of it and more.

It can carry a large amount, comfortably over a long distance. She is fast, rugged, and beautiful…

From all of us at A2A Simulations, thank you.

A2A simulations