

A2ASIMULATIONS

COMANCHE

PREPAR3D®



ACCU-SIM COMANCHE 250

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ACCU-SIM COMANCHE 250

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Ergonomic Advice

- ▶ Always maintain a distance of at least 45cm to the screen to avoid straining your eyes.
- ▶ Sit upright and adjust the height of your chair so that your legs are at a right angle. The angle between your upper and forearm should be larger than 90°.
- ▶ The top edge of your screen should be at eye level or below, and the monitor should be tilted slightly backwards, to prevent strains to your cervical spine.
- ▶ Reduce your screen's brightness to lower the contrast and use a flicker-free, low-radiation monitor.
- ▶ Make sure the room you play in is well lit.
- ▶ Avoid playing when tired or worn out and take a break (every hour), even if it's hard...

Epilepsy Warning

Some people experience epileptic seizures when viewing flashing lights or patterns in our daily environment. Consult your doctor before playing computer games if you, or someone of your family, have an epileptic condition.

Immediately stop the game, should you experience any of the following symptoms during play: dizziness, altered vision, eye or muscle twitching, mental confusion, loss of awareness of your surroundings, involuntary movements and/or convulsions.

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DYNAMIC ELEGANCE

Mitchell Glicksman



NO AIRPLANE PERSONIFIES THE EPITHET “Dynamic Elegance” more aptly than does the Piper Comanche 250.



The unique conjoining of many superlative aeronautic and aesthetic qualities marks this very special aeroplane. It has been said that if an aeroplane looks right, it will fly right. In this it is supposed that the eye's natural ability to sense the pleasing proportion and intrinsic efficiency of a design is a reliable predictor of similarly excellent aeronautic performance. The Comanche 250 proves that this adage may be relied upon and bears validity. The Piper Comanche takes its well-deserved place on an illustrious list of aeroplanes which are both so very pleasing to the eyes and which are equally capable of superior performance.

There are many including this writer who hold that the Comanche is among the most beautiful of all General Aviation (GA) aircraft, if not the most beautiful. From any angle the Comanche treats the eyes. This is what provides its elegance. Its superlative performance is a matter of record and this provides its dynamism. These two great and rare qualities, beauty and performance would be enough in and of themselves to place the Comanche at the pinnacle of GA aircraft, but the Comanche possesses an additional quality, one which, after all, may be its most endearing.

Of all of the high performance GA aircraft the Comanche is arguably the least demanding of the relatively low-time pilot. That this is so is not an accident or a fortuitous circumstance -- William Piper specifically intended that it should be so. The Comanche's forgiving flight characteristics and its refusal to turn and bite an unwary pilot without plenty of warning, its relatively gentle stall, easy handling at low airspeeds and its overall

delightful handling at all airspeeds are confidence boosters for its fortunate pilots.

The Comanche is also particularly exceptional in that it does not achieve its excellent aerodynamic performance at the expense of interior room and comfort; it is among the roomiest and most comfortable of “high performance” aeroplanes. Neither does the Comanche sacrifice useful load nor its generous weight and balance envelope at the altar of high airspeed. It is a highly capable heavy load hauler and its capacious useful load as well as its ability to safely carry baggage and substantial rear seat passengers without straining its aft load limits is far better than its closest competitors of equal horsepower -- including and specifically the V-tail Beechcraft Bonanza. Perhaps most importantly, the Comanche does not achieve its performance by the intrinsic design features which compromise stable flying characteristics. Its light airframe weight and its generous, high aspect-ratio, laminar flow wing provides the Comanche with high efficiency as well as a low wing loading.

Accordingly, Comanche pilots and owners are particularly loyal and satisfied, and for good reason; the Comanche delivers extraordinarily dynamic performance while embodying the highest degree of aeronautic elegance.

So, how is it that all of these superlative qualities came together in this aeroplane? Well, therein lays the Comanche's tale, one redolent of aeronautic expertise, prescience, confidence and also of a fierce competitive spirit. As it happens, it all began a little more than ten years before the first Comanche ever flew.

Once upon a time...

DYNAMIC ELEGANCE

THE MODERN AGE OF THE PRIVATE AIRPLANE BEGINS — ENTER THE BEECHCRAFT BONANZA

Summer, 1945 -- While the world is joyously celebrating the Allied victory in Europe, World War II is still savagely raging in the Pacific. The United States' combined armed services along with those of its valiant Allies are pressing forward, island by terrible island at horrific human cost, drawing an ever-tightening noose around the neck of the Imperial Empire of Japan. As the final victory and a new era of peace looms nearer and nearer the American General Aviation (GA) industry made up of companies such as Piper, Cessna, Ryan, Stinson, Luscombe and Beechcraft is already making plans for what they expect and fervently hope will come after the War is finally over. Unfortunately or perhaps inevitably, expectations, which are so often fragile and which are ultimately as insubstantial as vapour are also as precious as dreams; and like dreams expectations are often rendered irrelevant and are ultimately crushed by brutish reality. After almost four years of stifling limitations incurred by the unavailability of raw materials, machinery and workers, all of which and whom went into the War effort, the GA industry had become, or perhaps more accurately had succumbed to becoming manufacturers of solely that which the War Department required and demanded.

Thus, those American GA companies who persevered performed their needed part as highly regulated cost-plus cogs in the War's wheels, first under the WPB (War Production Board) and then under the OWM (Office of War Mobilisation), subject as well to the rules and regulations of the OPA (Office of Price Administration) and the WMC (War Manpower Commission). Piper, for instance, just as it was beginning to achieve the blessings of its long-worked-for financial success in the late 1930's was compelled in 1941 to convert its popular J-3 Cub into a military scout, an artillery spotter, a short-field, short distance transport vehicle for a pilot and a single V. I. P., and for a (mercifully) short while, amazingly, a motorless three-place glider trainer. Cessna turned out the AT-17 "Bamboo Bomber", a multi-engine trainer, the AT-17, etc., Beechcraft built the AT-7 Navigator/C-45/UC-45/CT-128 Expeditor

From its inception the Bonanza was intended to largely appeal to the corporate/business community as we see here. However, in this one we also see a little of the Western, "Camp out with your Bonanza" outdoor flavour which was another intended part of the appeal that Beechcraft wanted to make. There would be a lot more of this kind of appeal in ads to come and all of this coming long before the television show of the same name.

The main picture is interesting. These men must have been as small as elves to have that much head and shoulder room in the Bonanza's cabin. Also, those guys in the back had better have been very slim and lightweight, the V-tail Bonanza cannot take much of an aft load.

Hitch "Air Power" to Your Business with a Beechcraft BONANZA

What is a "true material" that is every business enterprise. But it is strictly limited supply. Twenty-four hours a day is all you get.

This is where "air power" comes in!

The new four-place Beechcraft Bonanza—a plane built for business—delivers and guarantees your apparent supply of time... when you need it most! The Bonanza's 172 mph cruising speed carries you to customers in many cities, where you formerly visited one. When you travel you're the boss... you say when and where you will go. And you do it with smooth efficiency, relaxed and comfortable in the Bonanza's roomy, wood-paneled cabin with an operating cost as low as one most get passenger mile!

Company-owned Bonanza transportation serves you night and day, any season of the year. The Bonanza is fully equipped with two-way radio, landing lights, instruments, heater, retractable landing gear, landing flap, controllable prop and many other refinements.

Your nearest Beechcraft distributor will show you facts and figures on Bonanza "air power" as it applies to your business. Beech Aircraft Corporation, Wichita, Kansas.

BEECHCRAFT BONANZA

versions of its sturdy and thoroughly excellent twin-engine Model 18, and so on with regard to all within the GA industry.

The irony of it was that for all of the splendid work and muscular energy spent producing aircraft for the war effort, none of these very mission-specific wartime airplanes were designed for or expected to ever be made available to the public at any future time. And so, while a small profit (very small to be sure) was earned from their military manufacturing efforts, the commercial aspects of GA manufacturers, at least for the duration of the War, came to a complete halt.

This is not to say that Piper and the other GA manufacturers did not sincerely desire to do their part in helping to win the war. Their officers and employees were as patriotic as the best Americans and their strenuous efforts substantially enabled the inevitable victory. That being said, as the War progressed they patiently waited and anxiously looked forward to the post-war era wherein they might finally reap the

sweet commercial rewards of their recent sacrifices by selling great shiploads of civilian airplanes to hoards of distinctly aviation-friendly and flight-familiar ex-service pilots.

In the summer of 1945, as the War wound down to its end, the owners, CEOs and Boards of American General Aviation manufacturers expected, or if you prefer, dreamed that their anxiously anticipated heighday was truly nigh. After all, they reasoned (with a heavy dose of wishful thinking) that when all of those young aviators come home after having experienced the joy and freedom of flying, they would surely wish to continue in a similar vein and become owners and pilots of their own airplanes. They further reasoned that when these young men (and some young women as well) having been released from the armed services saluted forth en masse, clamouring for airplanes to buy, the American GA Industry would be right there, blithely and heartily ready, cheerfully awaiting their chance



Notice the slow-moving automobile traffic below over which the sleek, sparkling silver Bonanza effortlessly travels.



More "Campout with your Bonanza". Business and pleasure combined — irresistible appeal.



Pure business appeal. Note the oil rig pictured. The upscale and super- expensive Bonanza was strongly pitched to the burgeoning oil business.

to supply the anxious needs and desires of these valiant and victorious aerial veterans. In any event, it sounded right and no one apparently thought that there was any flaw in that analysis and expectation.

One aircraft manufacturer however, Beechcraft, did more than merely dream. With the surrender of the Empire of Japan on September 2, 1945 which marked the end of W.W. II, the world commenced to dig itself out of mountains of ruin and rubble, account for and mourn numberless victims, and as soon as might be possible to get on with life in the bright and promising era of Peace. In the United States that which had been interrupted by the war was now busy re-commencing. GA manufacturers were now free to produce aeroplanes for the public with an unlimited supply of necessary materials and workers.

While virtually all of the other GA manufacturers planned on offering pretty much the same aircraft or types of aircraft that they has built in the pre-war 30's; Piper offering the J-3 "Cub", Cessna offering a distinctly pre-war style aeroplane, the 5 seat C-190/195 as well as the two-place, tailwheel equipped C-120, Taylorcraft, Aeronca, Stinson and Luscombe all once again offering their pre-war designs; Beechcraft had another idea, a new idea.

Beechcraft was bent upon producing a brand- new aeroplane, something not

only entirely different from anything that they had previously built, but something new and exciting that had not yet been seen in the GA world. This was the seminal Bonanza Model 35 which was to become the airplane that sparked and kick-started post-war modern General Aviation.

Remarkably prescient in every way, Beechcraft well-named the new aeroplane, "Bonanza". Even before Beechcraft had actually sold a single aeroplane, it was already a remarkable economic success. Shortly after its grand introduction to the public by way of press releases and magazine advertisements, corporations, businesses and wealthy professionals placed almost 1,500 orders in advance of its release with thousands more orders soon to come. Without any question the Bonanza was an unqualified and immediate roaring success.

In 1947 Beechcraft embarked upon a very powerful and sweeping advertising campaign to debut and introduce to the public what it was confident would create a sea-change in GA aviation. Beechcraft was right on all counts.

Let's take a close look at a variety of advertisements that illustrate the new market Beechcraft expected to serve with the Bonanza. Here are some early (1947) ads which were part of the campaign to introduce the Bonanza to the public:

BEECHCRAFT'S BIG IDEA

Designed by Ralph Harmon and his associates in 1945 as the war was coming to an end, the Model 35 Bonanza had its first test flight on December 22, 1945. Incorporating all of what was then known about aerodynamics, aircraft structure and aviation technology, the Bonanza's clean, stressed skin (monocoque) all-metal structure was reminiscent of the recently lionised Spitfires and Mustangs and in virtually every way was a distinct departure from previous mostly fabric covered, fixed-undercarriage, tailwheel GA aircraft.

The first Bonanza, the Model 35, had a retractable tricycle undercarriage, a distinctive V-tail which was unique for GA aircraft and had seats for four adults. The first Bonanzas were originally equipped with an interesting and curious laminated wood, electrically controlled, pilot adjustable, fixed pitch propeller. This was not an automatic constant speed propeller which was a common item even by 1945, but was a variable pitch unit electrically adjustable by the pilot to meet power requirements. Some early Bonanzas that are still flying still have this kind of propeller; however, most of these propellers have been converted to metal blades.

The Model 35 was powered by a simple to manage and inexpensive to run six-cylinder, horizontally opposed, air cooled

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165 hp Continental E-165 engine (O-470 family). High performance GA aircraft, including Beechcraft's, had traditionally been powered by large 7 or 9 cylinder, round radial engines which were thirsty of fuel and oil. A moderate sized, horizontally opposed engine in the Bonanza was a breath of fresh air which engendered the colour of progressive modernism while promising low fuel and oil consumption and a much quieter cabin.

Unsurprisingly, the Bonanza spectacularly burst onto the GA market and was undisputedly and justly acclaimed by all to be the first of a new breed of GA aircraft.

In 1945 at the time that the Bonanza was being conceptualised, what late in the following decade would become a new GA culture largely populated by casual weekend aviation hobbyists who were primarily relatively low-time VFR-only pilots and who flew in order to take their friends and families aloft for pleasant, good-weather aerial jaunts and vacations and to consume that \$100 hamburger in a restaurant at some distant airport, did not yet exist, nor could it then have then been foreseen. Accordingly, in 1945 Beechcraft's design philosophy and the targeted market for the Bonanza was, as we shall see, in no way aimed at the part-time aviation aficionados to come, but at an entirely different group of highly experienced pilots who it was expected would own and/or be hired to fly Bonanzas for businesses and corporations.

Beechcraft's goal and expectations for the Bonanza were clear: To create the fastest aeroplane for its horsepower that could carry up to four in relative comfort which would be primarily purchased by prosperous individuals, corporations and businesses to be used as a luxury executive transport flown by experienced, ex-military service pilots.

Yes, all during the war most Americans hoped for, waited for, and expected that peace would bring forth a brave and prosperous New World, a World which in August, 1945 had finally arrived. Beechcraft's particularly clear prescience was that this New World's skies would be greatly populated with aircraft of all shapes and sizes in general and with its new, game changing Bonanza in particular.

As said, Beechcraft's plan included the idea that those who would mostly be

flying the Bonanza would be primarily those valiant young ex-Army, Navy and Marine Corps aeroplane drivers who had of late been regularly flying and fighting at 40,000' and at up to 400 MPH +. Many of these soon- to- be Bonanza pilots had regularly flown massive, heavy, four-engine aircraft on perilous high-altitude, long-range missions over Europe, East Asia and throughout the Pacific Theatre. It was assumed that they would not likely regard flying the neat and trim little four-seat Bonanza with its 165 h.p. engine to be much of a challenge. These were the pilots whom Beechcraft expected would be filling the rolls of those who would be flying corporate V.I.P. s, business officers and representatives to and from board and sales meetings all over the country in post-war peacetime America. Beechcraft's mission was to see that as many of them as possible would be flying Bonanzas.

Beechcraft's vision turned out to be at least partly true as it was primarily ex-transport and bomber pilots who filled out applications with businesses and corporations of all kinds to become aerial chauffeurs. Apparently most of the fighter pilots had had more than their fill of what was, from their perspective, the "joy" and "thrill" of flying.

What this meant regarding the design of the Bonanza was that Beechcraft properly understood that these ex-military pilots would need no coddling when it came to providing an aeroplane suitable for them to fly. Accordingly, taking extra care to design the Bonanza to be a gentle and easy handling aeroplane for a multitude of casual, weekend, sportsman pilots did not appear to be any part of Beechcraft's intent or concern. It seemed that a clean design was paramount, which could be sold most readily, i.e. performance -- high speed, fast climb, long range, efficiency, comfort, as well as owner's prestige and a kind of modern-world cool sexiness -- everything that makes an aeroplane exciting and satisfying to behold and to fly.

Not surprisingly the Bonanza's fast-growing reputation as the "best", and "most modern" private aeroplane attracted a great many wealthy and well-healed professionals and "sportsmen", many of whom had no more than perhaps a few hundred hours flight time, if that much, and who were largely of limited

aeronautic experience. They were used to possessing whatever they wished and could easily afford the newest of the new and the best of the best. Not accidentally Beechcraft had placed Bonanza squarely in that class of possessions; but therein was the rub.

All aeroplanes are subject to that most basic law of physics: where one thing is gained, another must be diminished. Accordingly, the design of all aeroplanes necessitates many compromises. For instance, maximum airspeed and performance for available power is generally and most readily obtained at the expense of various other flight characteristics that would, say, make the aeroplane suitable as a casual touring aeroplane, and vice versa. Compromises in design must be made favouring that which the manufacturer sees as its goal for any particular aeroplane. To achieve specific design goals such as high airspeed, comfortable cabin space, long range, heavy load carrying, gentle handling, moderate runway requirements, etc. designers make choices regarding an aircraft's dimensions, geometry, proportion, materials, weight, airfoils, thicknesses, shapes, wing and power loading, etc. In creating a design which would extract maximum airspeed from available power, the Bonanza's designers clearly made specific choices and compromises, many of which did not favour the low-time pilot.

After a tragic V-tail separation during early flight testing in 1946 which caused the death of the test pilot and extensive re-design and re-testing of the tail surfaces (but not to a sufficient degree as we shall see), the existing problems seemed to be cured and all went well. By the end of 1947 the first gleaming silver Bonanzas rolled off the assembly lines. In its class and for its time it was the epitome of GA aeronautical design and engineering -- fast, beautiful and looking like nothing that had come before. Sure, it was pricey at the then great sum of \$7,975.00 (\$84,613.32 in 2015), however a 2015 Bonanza G36 costs approximately \$691,390 depending upon installed electronics, equipment, etc.), but to its well-healed purchasers price was no object. In fact, the Bonanza's high price guaranteed exclusivity and granted its owner distinct prestige and pride of ownership.



The would-be fighter pilot's dream, the Cavalier Mustang appears here in civilian paint. Many were finished in "military" colours and some with authentic camouflage and markings. While surely an exciting prospective mount for any pilot, the Cavalier required long and extensive training and was expensive to both purchase and to maintain. It wasn't for everyone and was not produced in large numbers.



The Bonanza early safety record might have been better if more of these pilots entered general aviation after the war.

Upon the pre-production introduction of the Bonanza through an extensive advertising campaign (see above) more than 1,400 paid pre-orders for the aeroplane flowed into Beechcraft's sales offices like a raging tide. Once production commenced the waiting list to purchase a Bonanza was in the many thousands.

Unfortunately, in those transitory and

awkward post-war years the Bonanza's commercial success story was not at all the rule but the great exception. Encouraged by the early and enormous success of Beechcraft's Bonanza the other GA aeroplane manufacturers breathlessly anticipated that they, too, might experience similar success and so they waited for the long- predicted hordes of customers to come crashing in and snatching up their aeroplanes. They waited, and waited and waited.

As virtually all of the rest of the GA industry lay substantially dormant, the Bonanza firmly and thoroughly established Beechcraft as the cutting edge and the undisputed leading GA aircraft manufacturer throughout the late 40's and through 1950s.

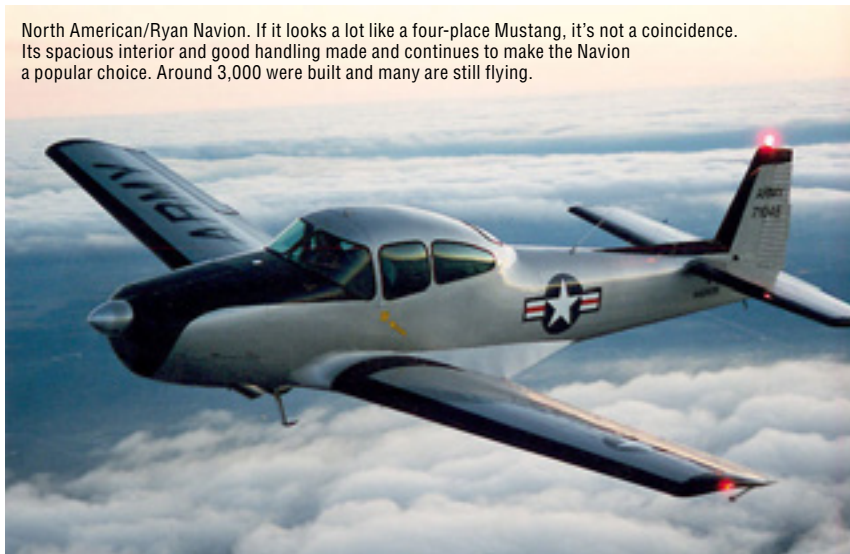
From its introduction the Bonanza had been and was intended to be an instant status symbol, a totem upon which its owner might boldly announce apparent success and wealth. Very like Rolex,

Cadillac or Rolls-Royce, its exclusive high price and universally recognised quality put the Bonanza in an exclusive class which was highly attractive to businesses and individuals who wished to be seen and regarded as having the means to indulge themselves in such conspicuous, "gold-hatted, high- bouncing" consumerism. And so it was that throughout the 50's the Bonanza's reputation and sales continued to soar and dominate the GA industry; its place at the top of the GA food chain remaining essentially unchallenged.

However, during the late 40's and early 50' the Bonanza did have a few notable ambitious would-be competitors such as the ultimate exotic, the civilianised P-51 fighter -- The Cavalier Mustang, the North American/Ryan Navion, a four place low-wing, all- metal GA aircraft based, no less, upon the airframe of the P-51, the sleek and swift Meyers 200, the efficient but cosy Mooney MK-20, the classic Bellanca 14-13 Cruisair Senior and the 14-19-2 "230"

DYNAMIC ELEGANCE

North American/Ryan Navion. If it looks a lot like a four-place Mustang, it's not a coincidence. Its spacious interior and good handling made and continues to make the Navion a popular choice. Around 3,000 were built and many are still flying.



Meyers 200. Similar in appearance and performance to the Navion but without the Navion's "Mustang" heritage, the excellent Meyers 200 nevertheless should have been but was not a commercial success.



The Bellanca Cruisemaster. A totally original design, fabric covered plywood structure with a wooden spar wing. Quirky in appearance and manufactured using old-school construction methods and materials, the otherwise excellently performing Bellanca was not a popular post-war choice.



The Globe Swift. Two place and aerobatic it was and is the classic "poor man's" fighter aircraft. Many were sold, but being so small and lightweight, it was not really in competition with the Bonanza and was never a real challenge.

Cruisemaster, and the sporty, aerobatic, two-place Globe/Temco Swift. However, as excellent as these aeroplanes were and are, not one of them, nor all of them together put an appreciable dent in the sales and popularity of Beechcraft's star and king of the single-engine GA hill.

PIPER STEPS UP TO THE PLATE

During World War II while it was performing turning out militarized versions of the J-3 and, of all things, glider trainers created by cutting off a J-3's engine and replacing it with a streamlined nose section, Piper Aircraft did not entirely intend to rest upon the popularity of its J-3 Cub as its sole post-war product. The Comanche which was to come to light in 1958 was Piper's first low-wing, all metal, single engine aeroplane, but it was not the first one of that type that they contemplated. At least two Piper designs intended to be produced after the war were created in 1944, the PA-6 Sky Sedan and the PA-7 Skycoupe.

Originally named the PWA-6 and looking very like the Ryan Navion, the prototype Sky Sedan was a fabric-covered metal frame, four-place, low-wing, "family" oriented aeroplane. Originally designed to be powered by a 140 hp Franklin engine, the prototype was later actually powered by a 165 hp Continental E-165 engine (ironically the same engine as was used in the Bonanza). While a favourite of William Piper, the Sky Sedan's performance with its relatively anaemic engine was predictably unexceptional and disappointing, so the project was laid to rest until after the war. In 1947 the second and last Sky Sedan, named PA-6, was now all metal, was now powered by a more appropriate 205 hp Continental E-185 engine, and had a one-piece windscreen.

Most painfully cognizant of the Beechcraft Bonanza's well-deserved success, by the middle 1950s Piper Aircraft was anxious to produce its own modern, all metal, retractable gear, high performance single-engine aeroplane. Seeking to enter and to dominate the high-performance GA business aeroplane market and unseat the now long-term, highly successful Bonanza, Piper Aircraft made ready to topple the King and to take its place on the GA high-performance business aeroplane throne.

To this end, what became the Piper

PA-24 Comanche was developed to be “The Bonanza Killer”. It was Piper Aircraft’s ambitious intention to not only put an end to the Bonanza’s reign, but to put Piper firmly on the map as GA’s leading and most advanced aircraft manufacturer. Piper knew that to do all of this would require an exceptional aeroplane, one that was built and performed to the highest standards, was roomy and comfortable on long flights, had solid, stable, predictable handling and exhibited gentle and forgiving flight characteristics.

Of all, this last requirement was key. Piper, having analysed the Bonanza design was well-aware that as a trade-off for its outstanding performance, Beechcraft had incorporated features in the Bonanza which compromised pitch and roll stability, C. G. loading, slow and departed flight regimes (stall/spin) and ease of flying, making their otherwise excellent aeroplane more than a bit if a handful for low-time and less experienced pilots. Piper could clearly see the potential commercial benefit of creating a better handling and performing aircraft using more modern techniques and knowledge, and was confident that their new aeroplane would be highly competitive and would deliver excellent performance without going down the same route of the Bonanza.

THE CRACK IN THE KING’S MIRROR

For all of its beauty, innovation, performance and commercial success the Bonanza, when Piper more closely looked upon it, showed that it possessed a number of serious design compromises which Piper believed were dubious at best and alarmingly dangerous at worst. Mr. Piper was convinced that he and his company had the ability to design and produce an equal or better performing aeroplane in every respect. By applying more advanced aerodynamics and with a stronger, better configured airframe, their new airplane would possess overall gentle and predictable handling as well as solid, high speed performance without compromise.

To be fair to Beechcraft, by the time that Piper began to design the Comanche in 1957, the Bonanza design was then more than a decade old, and had fundamentally changed very little and was showing its age. Yes, over the years Beechcraft



A 1945 advertisement to test the water as to how the public might react to the Sky Sedan. The performance claims therein are, well...a bit optimistic.



Another 1945 press release regarding the PA-6.



1947 Piper PA-6 Sky Sedan planned advertisement photo. This is the second and the last one to be built.

Note: GA aircraft advertising then and today makes all aeroplanes look roomier than they may actually be by placing in the cockpit the smallest available passengers it can find for photographs. Note the emaciated looking pilot and the miniature children.



Piper PA-7 Skycoupe looking like something from the film “H. G. Well’s Things to Come”.



The only Skycoupe ever built. An interesting and futuristic design, “It didn’t fly worth a damn!” said Pug Piper of it.



THE HENRY FORD OF AVIATION

William T. Piper was an extraordinary person. He had an idea, a dream perhaps, that the light, private aeroplane would become as ubiquitous in American society as had the automobile. Merely having an idea (or a dream) was not; however, what made Mr. Piper extraordinary. Mr. Piper was, one might reasonably say, a stubborn man. Once this idea had firmly situated itself in his imagination, he went to work to make it become a reality, and through fire and flood he never ceased applying all of his being towards that end.

Piper did not enter the aeroplane manufacturing business until 1929 just as the Great Depression was about to commence. He was not an engineer nor even at that time a pilot (he did eventually obtain his private pilot's licence in 1941 at the age of 60). Up until then Piper had been a successful crude petroleum developer operating a number of lucrative oil wells in and around Bradford, Pennsylvania. Piper only became aware of the Taylor Aircraft Company and its economic failure by accident in that he was one of a number of successful local businessmen who were seeking to shore up failing businesses in Bradford so as maintain and foster local industry.

In 1929 Piper, seeing that the Taylor company was about to drown he purchased \$600 worth of Taylor Co.'s then worthless stock. Unfortunately this salvatory investment was insufficient to stave off incipient commercial disaster and Taylor went bankrupt in 1931. Piper then bought the land and buildings owned by Taylor Co. at the bankruptcy sale for \$761.00 and permitted Taylor to use the facilities rent-free. Piper became the treasurer and a board member of the new Taylor Aircraft Company with C. G. Taylor the President in charge of engineering. Piper reserved for himself the responsibility to raise capital for the new company and was, appropriately, the chief salesman.

After a few abortive and tentative attempts to re-invigorate Taylor Aircraft Piper persuaded C. G. Taylor to design an entirely new and far simpler aeroplane than the old complex Taylor "Chummy" which was expensive to build and, accordingly, carried too high a sales price. That new aeroplane eventually became the J-3 Cub.

There are many similarities between Henry Ford and William T. Piper. Both men recognized early in their careers that there was an untapped market for their particular products that could be opened wide if an affordable

and reliable product became available. They both understood that a good, solid but no-frills automobile/aeroplane could be designed and so economically manufactured that it could be offered at a price that most Americans could afford. Like Ford, Piper also implemented a kind of assembly line to produce aeroplanes, cannibalising an old, broken carnival Ferris wheel and parts from an old barn.

Despite his efforts to streamline the Piper aircraft assembly process, the hard fact is that aeroplanes require far more skilled hands-on work to build that do automobiles. Accordingly, Piper needed a fairly large, well trained work force in his factory. By 1940, with America still deep in the throes of the Depression, he employed more than 1,000 men and women full time, average age 23, to build Piper aeroplanes.

In the United States in the late 1930's and early 1940's the volume of all light aircraft sales did not even approach one-hundredth the volume of sales of automobiles and Piper Aircraft Co.'s share of the aviation business was, of course, only a percentage of that. Piper could only afford to pay his employees a maximum wage of .40¢ per hour while the contemporary automobile worker made as much as .93¢ per hour. To keep

his employees he offered them incentives, as had Henry Ford in his early days.

He offered his factory workers the opportunity to rent a Piper Cub to take lessons in or to just to fly if they already were pilots for no more than the cost of the gasoline and oil, which equalled approximately \$1.00 per hour. In an article about William T. Piper Fortune magazine said, "He could tap an unlimited reservoir of smart, eager boys, so crazy about flying that they were willing to work for nothing if they could only start their days off by laying hands on a Cub wing." As a sales incentive Piper also offered any J-3 purchaser eight hours free flight instruction. As a kind of gentle "payola" he extended this to the media as well, offering free flight training to writers who would help to expose the public to Piper's aeroplanes.

Like Ford, Piper had a firm conception of what his company's economic place was and how he could use it to foster Piper sales. Regarding the vast economic Depression that was overtaking the world in the 1930s Piper later said, "Everyone who was still flying was starved into using Cubs." Also like Ford, Piper chose a single colour for his aeroplanes. Ford had chosen black, Piper chose yellow.

F-4U-1 Corsair
"Birdcage" landing
during aircraft
carrier trials on the
USS Sangamon on
25 September 1942.
With flaps full down
the left wing has
suddenly stalled
before the right wing,
a trait common to the
NACA 23000 series
airfoil which was
incorporated in this
aeroplane. (notice that
the pilot has applied
full right rudder to
try to prevent going
over the side. He has
correctly applied no
right aileron because
trying to pick up a
wing with aileron when
in a stalled condition
in an aeroplane of
this class is usually
a fatal mistake.)



had made a scant few improvements and changes to the original Model 35, specifically with regard to higher performance specs created by simply increasing horsepower, but the Bonanza of the middle to late 50's was essentially and substantially the same as the 1946 model.

The 1957 Bonanza "H" was the first of the high-powered Bonanzas. Except for the marked increase in horsepower it, too, remained essentially the same as the 1947 Model 35. It has the Model 35's highly tapered wing with an area of only 177.6 sq. ft. to lifting its 3,050 lb. gross weight (after various supplemental type certificates (STCs)). This puts its wing loading (maximum gross weight divided by wing area) at 17.17 lbs. /sq. ft., which was then the highest wing loading for a single-engine GA aeroplane of its class and size (excepting the Cavalier which was, of course, a civilianized P-51). As a comparison, a lighter Piper Comanche at 2,800 lbs. gross weight with a wing area of 178 sq. ft. has a lower wing loading of 15.7 lbs. /sq. ft.

That the Bonanza's wing was smaller than perhaps it ought to have been was a deliberate design choice. The shorter span and less wetted area of the Bonanza's wing permitted greater airspeed but, of course, greatly increased the Bonanza's wing loading. Such airspeed gains as may be had thereby come at the expense of ease of

flying for less experienced pilots and more importantly, of safety for all pilots.

An aeroplane with a higher wing loading is more critical of less- than- expert piloting techniques, particularly at lower airspeeds and is more likely to literally turn and bite if not handled expertly and well. Aircraft with high wing loadings are more likely to suddenly enter an accelerated stall (reaching critical Alpha) even whilst airspeed is well above normal stalling airspeed (V_{so}) by turning too sharply and/or suddenly applying positive pitch. Also, a high wing loaded aircraft is usually more likely to spin out of an ordinary stall and more likely to spin out of an uncoordinated turn at low airspeeds.

While Beechcraft actually experimented with a laminar flow airfoil on early Bonanza prototypes, it ultimately and conservatively selected the old NACA 23000 series airfoils (wing root - 23016.5, wingtip - 23012) for the Bonanza. The NACA 23000 series airfoil dates back to 1935 and was very widely used throughout that and the following decade. The U. S. Navy F-4U Corsair and F-8-F Bearcat incorporate this airfoil.

While the NACA 23000 series airfoils are reasonably useful for higher airspeed applications provided appropriate power is available, it does not produce as predictable and benign departed

flight characteristics as the Comanche's even faster and far more modern, scientifically designed NACA 64(2)-A215 laminar airfoil. This is partially but primarily because the 23000 series of airfoils exhibit a rapid Cl (Coefficient of Lift) decline when approaching stall Alpha (angle of attack) and thereby are likely to produce a rather abrupt stall/spin.

Precipitous left wing drop during landing was a serious and dangerous problem for the F-4U-1 Corsair which, like the Bonanza, incorporates a NACA 23000 series airfoil. This and other problems initially disqualified the Corsair for U.S. Navy aircraft carrier duty (although the Royal Navy, desperate for a real, purpose-designed carrier aeroplane, gladly accepted it even with its serious low speed handling flaws in June 1943 as the "Corsair I.")

Accordingly, if for example when flying an aeroplane with this airfoil such as the Bonanza a pilot should overshoot his turn to final, pulling harder to tighten the turn may result in a sudden stall with an accompanying sharp wing drop or possibly an over-the-top spin. Even during a normal landing with full flaps, getting too slow in a Bonanza can result in a sudden wing drop, etc. Both of these scenarios have resulted in numerous fatal accidents during landings in the Bonanza.

The Bonanza's V-tail, so designed to

DYNAMIC ELEGANCE

reduce drag by eliminating one entire tail surface and to look very cool has its advantages and also some apparent detriments. In addition to its distinctive appearance and even though each of the two surfaces of the V-tail are larger in both span and chord than any of the surfaces of a comparable three - surface conventional cruciform tail, Beech believed that the V-tail would save weight and possibly create a bit less drag. While not hard scientific fact, perhaps the V-tail does help Bonanzas fly a bit faster, but it is reported by many pilots to be not as stable at slower airspeeds as a conventional tail. Some pilots have reported that they “ran out of rudder” in strong cross-wind landings in a Bonanza. This phenomenon might have actually been caused by the Bonanza’s yoke and rudder pedals bungee interconnect system designed to enable coordinated turns with the yoke only. Some pilots have reported that the V-tail’s stall/spin characteristics are, to put it politely, not as benign as those of aeroplanes with a conventional tail; although this may be more due to the Bonanza’s high Alpha- sensitive airfoil. As to V-Tail characteristics, opinions may vary.

Wind-tunnel tests later showed that the Bonanza’s V-tail was also not structurally sufficiently robust and it would become the focus of inquiry with regard to fatal accidents involving airframe failure in flight.

Some believe that Beechcraft’s original design philosophy regarding the Bonanza, i.e. that since it would be largely flown by highly experienced, professional pilots that its flight characteristics need not lean towards ease of flying for low-time pilots, came home to roost as the number reports of a number of structure-related accidents began to toll during the 1950s. It was discovered that in virtually all of these accidents where the airframe had failed in flight that the probable cause was attributable to either the pilot’s loss of control and/or the pilot’s over control upon attempting a correction. Most of these accidents occurred whilst a relatively inexperienced pilot was hand-flying the Bonanza in IFR conditions and in many instances while the aeroplane was loaded so that the C. G. (centre of gravity) was chock up against or beyond its maximum permissible aft location.

A very serious V-tail Bonanza characteristic is that it is quite sensitive to

Compare how the Comanche’s main wing is set further back, making it more suitable for carrying heavy aft loads while staying within safe centre of gravity limits.



You can see, by comparison, the Comanche’s wing is 1-2 feet further back.



weight and balance/C.G. considerations. Early V-tail Bonanza’s (Model 35 through 35J) have a rather narrow C. G. range of 9.2”; i.e., between 76” and 85.2” aft of the horizontal reference datum line. As a comparison the 1958 Comanche 250’s C. G. range is 12.5”; that is, between 80.5” and 93.0” of the datum line. This indicates the Comanche 250 may be loaded over a far greater distance aft of the datum line than a Bonanza 35H. Accordingly, it is particularly easy to inadvertently load an early V-Tail Bonanza aft of its rear limits.

It is not well known, but all V-tail Bonanzas, from the first until almost the last, have a down spring connected to the elevator control system which imparts a constant forward push on the control wheel. The elevator trim could override this but it is always “on” and cannot be turned “off”. An elevator control down spring is a

very unusual item for a GA aeroplane. That Beechcraft felt that it was necessary to install this on the Bonanza speaks volumes about the V-Tail design. It also makes one wonder if Beechcraft knew full well that its speedy little aeroplane had some serious control issues at low airspeeds which additionally would be greatly exacerbated by a too-aft C. G. loading. With this revelation one may justly wonder how the V-tail Bonanza originally passed and continued to pass airworthiness muster with the CAA (Civil Aviation Administration) and later the FAA (Federal Aviation Administration).

Ironically, it is the Bonanza’s greatest characteristic, its aerodynamic cleanliness, that has been the cause of a good deal of the peril experienced by low-time Bonanza pilots who have recently transitioned to the Bonanza from lower-performance aircraft. Unlike slower fixed gear aeroplanes, higher performance, streamlined,

retractable-gear airplanes will pick up speed at an alarming rate by comparison when the nose is lowered in flight. Once airspeed is well-into the airspeed indicator's yellow arc and certainly if it is past the red line, any attempt to level the wings and/or bring the nose back up which is not executed with extreme delicacy and expertise (and in many instances even when performed so) will result in exceeding design G-load, over-stressing and ultimately distorting the wings and/or the V-tail which then is rendered useless to positively alter the aircraft's pitch so as to regain level flight causing the wings to fail and resulting in the aircraft breaking up in flight.

Essentially, it requires very gentle rearward yoke pressure and some good fortune to safely pull an over-speeding Bonanza back to level flight and to slow it down before something breaks. Too much rearward pressure when flying too fast and a wing or two "may assume an independent flight path from the rest of the airframe" (credit to Darryl H.). Combine this trait with an obscured or not visible horizon situation or in actual IFR conditions and where the unstable roll axis causes one of the wings to drop as it will eventually do if not strictly attended to, you have the all-too-common deadly spiral dive. To make things even worse, if the aircraft is loaded near, at or beyond its maximum permissible aft C. G., which as said is all-too-easy to do in a V-tail Bonanza, elevator response becomes considerably more sensitive and catastrophic over-control in an attempted pull out becomes even more likely.

Assembling and analysing all of the information at hand over more than a decade the CAB determined that a VFR pilot hand-flying the V-tail Bonanza in IFR conditions was virtually certain to quickly enter into a spiral dive and ultimately suffer a fatal crash.

ABOUT SPIRAL DIVES...

On 16 July 1999, John Kennedy Jr., was flying his new Piper Saratoga II HP, the 300 hp retractable undercarriage Cherokee Six from Essex County Airport, New Jersey to Martha's Vineyard on a hot and hazy summer's evening with his wife and her sister also on board. He had only 310 total flying hours and only 36 hours in this demanding, high-performance aeroplane, some instrument training but no instrument



Spiral Dive

ticket. At some point over the water he lost sight of the horizon and suffered from spatial disorientation. Inevitably, one of the Saratoga's wings went down and the nose dropped. As airspeed wildly increased he tried to pull up nose to slow the aeroplane but merely tightened the spiral until the Saratoga hit the water.

Many Bonanza pilots who were not professionals and those who were not used to flying such a clean airplane which was additionally unstable in roll found the aeroplane to be more than a safe handful.

In the 1950s and early 1960s legal IFR flying activity by GA pilots was very rare. The IFR system was then still fairly crude and not so widely available as it is today. Additionally, in those days very few GA and even ex-military pilots had instrument ratings or had received any serious IFR training. Accordingly, the vast majority of Bonanza pilots were strictly VFR rated and this was what got so many of them into serious trouble.

As time passed and more and more V-tail Bonanza in-flight structural break-ups were reported, in 1989 Beechcraft performed a series of wind-tunnel and other practical tests on the V-tail Bonanza. It was discovered that as designed the sensitive V-tail could not be relied upon to permit safe pilot application in the pitch axis even when the aeroplane was flown within and at one corner of its certified flight performance envelope. This could result in structural failure of the V-tail which would cause the aircraft to quickly exceed its safe airspeed limit and break up in flight.

V-TAIL AND C.G.

When the C.G. is too far aft in any aeroplane the pilot will experience, assuming that he or she is able to takeoff without mishap, overly sensitive elevator control at cruising airspeeds and a sharp deficiency of elevator control at low airspeeds, such as when taking off and landing.

CAB (Civil Aeronautics Board the predecessor to the NTSB - National Transportation Safety Board) accident records show that a too far aft C. G. was tragically all-too-often the probable cause of fatal accidents involving early V-tail Bonanza's. They found that in many instances an inexperienced or negligent V-tail Bonanza pilot loaded the aeroplane even slightly too far aft and thereafter experienced serious, often fatal low-air-speed pitch control deficiency and/or pitch over-control at high airspeeds leading to structural failure.

It should be mentioned in all fairness that modern, cruciform-tail Bonanza (which is actually the Debonair) have very generous horizontal weight and balance envelopes and do not suffer from the above mentioned condition.

The early V-tail Bonanza's controls are considered to be rather light and sensitive in normal operations, and while the aeroplane is only modestly stable in the pitch axis (constant hunting whilst cruising), it is far less stable in the roll axis.

Reinforcements, stiffeners and cuffs were applied to the V-tail which caused Beechcraft a good deal of angst as this was proof positive that the Bonanza's original design which was produced for 35 years was not adequate and was a contributing cause of many fatal accidents.

In 1960, Beechcraft produced the Debonair, a slightly dressed-down Bonanza with a conventional cruciform tail. Many pilots report that the Debonair is a better flying aeroplane than the Bonanza at all times and particularly when in turbulence and that it does not tend to "hunt" in pitch during normal cruise as do V-tail Bonanzas. Most significantly, the conventional tail Debonair's fatal accident record is 24 times better than the V-tail Bonanza's. Because of all of the above in 1982 Beechcraft stopped production of the V-tail Bonanza, dropped the Debonair model



Mooney M-20 with
German registration on
an airfield in Germany



1958 Piper
Comanche 250

and name, and continued to produce and develop what is, in fact the conventional tail Debonair, now calling it Bonanza.

To be fair, much of what caused low-time pilots to have a very high rate of fatal accidents when flying the Bonanza was, as with John Kennedy, Jr. in the similarly high - performance Saratoga, more due to

their inexperience with high-performance aircraft than any fault of the thoroughbred, high - spirited Beechcraft. However, because of its extremely high accident rate, mostly while being flown by private pilots without instrument ratings and no more than 300-400 hours total flight time, the Bonanza became popularly known as

the “The Doctor Killer”, referring to the many well-off physicians who could afford to purchase one, but who lacked sufficient flight time and expertise to fly it safely, and who thereby came to a tragic end.

Additionally, as said, there have been a rash of Bonanza structural failure accidents having to do with wings being pulled off after unintended over-speeding and too abrupt pull outs.

ENTER THE COMANCHE

William T. Piper knew that in seeking to enter the high-performance, single-engine business aeroplane market and challenging the iconic Bonanza that he was he was taking on a very tough, commercially risky task. As mentioned, from the company's inception, all production Piper aircraft had been high wing, fabric covered aircraft. However, by the mid-1950's Piper was already planning for the future and making changes towards the production of a more modern fleet. Indicative of this, in 1954, in a single dramatic and bold

move, Piper splashed into the modern GA market with its first low-wing, retractable undercarriage, all-metal aeroplane -- the four-seat, twin-engine PA-23 Apache which was the first Piper to be named for a Native American tribe.

Closely following his original concept of simplicity which had created the venerable "Cub", Piper had his engineers design a simple, no frills and relatively inexpensive but well-performing light twin, the Piper Apache. It quickly proved to be highly popular and, among other things, filled the niche as an ideal and economical multi-engine trainer and well as a personal touring aeroplane with the ostensible "safely factor" of a second engine (some pessimists say that having two engines simply doubles your chances of an engine failure, but that is a minority opinion).

Besides enjoying a solid commercial success, in the course of manufacturing the Apache, Piper Aircraft gained experience and confidence with regard to the particular methods and ways of modern all-metal aircraft production. The days of the highly labour-intensive fabric covered tube frame aircraft designs such as the Tri-Pacer were quickly waning and with success of the all metal Apache Piper saw that the way was now clear for more of the same.

During the four years after the Apache was introduced, Piper was actively planning to achieve its program regarding taking the Bonanza's place in the high-performance GA market. There is more than one popular, possibly apocryphal version of the genesis of the Comanche design, one of them is -- Looking around for a suitable high performance design, it happened that a Mooney M-20, which had been introduced in 1955 and which was known for getting very high cruise numbers (149KTS top -- 143KTS at 75% power at 7,000') for its 150 hp (110 kW) Lycoming O-320 engine,, was temporarily hangered at Piper's Lock Haven PA factory. As the story goes, William T. Piper and his engineers gave it a long, close look, measured every aspect of it and used what they found to come up with the Comanche design.

Another version goes like this -- William T. Piper (or Howard "Pug" Piper, William's son, depending upon from whom you are hearing the story) approached designer Al Mooney with an offer to buy the M-20

design which would, with some modifications, thereafter become the new Piper aeroplane. However, Al Mooney refused to sell, but as an alternative Mooney offered to design a brand-new aeroplane for Piper to their specifications. According to this version of the story, the specific design features that Piper asked Mooney to incorporate were: high cruise performance for available power (a Mooney trademark); a relatively simple, light airframe and components which would be economical to manufacture permitting Piper to greatly undercut the Bonanza's notoriously high price; a more spacious and comfortable cabin than that of both the rather short and narrow M-20 and even of the fairly capacious Bonanza; and, especially a new, uniquely modern appearance which would suggest speed and efficiency to the aeroplane-buying public.

Whatever the truth of the matter may be (and I lean towards the second story) there is no question that the final Comanche design and the M-20 share many features. Accordingly, it appears more likely that Al Mooney and "Pug" Piper, who was in charge of the development of the new Piper aeroplane, cooperated to complete the final design of what was to be Piper Aircraft's first all-metal, low-wing, single-engine aeroplane.

To foster the "jet-age" sales concept the Comanche's design implemented was what was then an innovative swept-back, jet-like vertical fin and rudder, the first one of its kind to appear on a mass-produced GA aeroplane. This design feature was something of an inside joke as it simply reversed Mooney's signature forward sweeping tail.

The question always asked about swept tails is whether with regard to an aeroplane that flies very far below trans-sonic or supersonic airspeeds does the application of a swept tail increase airspeed? With the Cessnas that changed to swept tails at least there was some means to compare the two configurations. In the instance of the Cessnas the answer is that where all other things are equal; no, there is no measurable increase in airspeed,

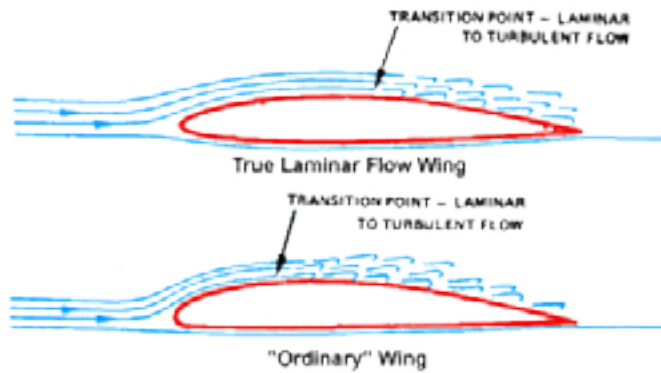
Unlike the Cessnas, there is no way to compare a straight-tailed Comanche with a swept tail version, so there may be no definitive answer forthcoming. However,

taking the Cessna example into consideration, the answer is most likely that the swept tail on the Comanche does not cause any increase in airspeed. However, it sure does look nice -- and fast.

Other innovative design features for a GA aeroplane incorporated into the Comanche's design are the single-piece, all-flying stabilator with anti-servo tab; an all-metal wing with a metal spar (1950's M-20s had fabric covered wings with a wooden wing spar and fabric covered wooden tail surfaces); and an NACA 64(2)-A215 laminar airfoil similar to that of the North American P-51 "Mustang" which airfoil was designed to permit the highest possible cruising airspeed for available power. The Comanche's wing has five degrees of dihedral for good lateral stability while still retaining excellent roll rate.

The "laminar flow" airfoil is the invention of Eastman Jacobs, an aerodynamicist who worked for NACA (National Advisory Committee for Aeronautics, the predecessor to today's NASA- National Aeronautics and Space Administration) in the 1930's. It was well-known by then that the thin layer of air closest to the surface of an airfoil, called the "boundary layer", was highly significant with regard to the wing's production of lift and influenced the way that high and low pressure areas were distributed as they moved from the wing's leading to trailing edge. Jacob's conception was that if the boundary layer could be made to adhere to and remain parallel to the airfoil's surface for a longer distance from the leading edge of the wing than the common airfoils being used, drag would be markedly reduced. Through wind-tunnel tests Jacobs determined that the thickest part of the airfoil where the local pressure was lowest best sustained an attached and parallel laminar flow boundary layer, but that as the airfoil became thinner and local pressure became higher the usual drag-producing vortices and eddies in the boundary layer began to arise, eventually becoming turbulent and producing a good deal of drag. Jacobs realised that if the thickest part of the airfoil was moved back from its usual 25-35% position from the leading edge to, say, the 40-50% position, that a good deal of the drag produced by the long rear section of turbulent boundary layer could be avoided.

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Note that the laminar flow airfoil's thickest point is farther back from the leading edge than the ordinary airfoil's.

Additionally, the following is extracted (and slightly edited) from the A2A Cherokee 180 Manual as it applies equally to the Comanche:

"Just a quick word or two about airfoils and what a "laminar flow airfoil" is. The wing's airfoil is its cross section shape from leading to trailing edge and current aerodynamic theory holds that the airfoil is primarily and most importantly an air diverter. Among other things, the airfoil diverts the air through which an aeroplane's wing travels downwards at the wing's trailing edge so that lift may be generated (see Newton's Third Law of Motion). In order to do this the "boundary layer", which is the very thin, viscous layer of air closest to the surface of the wing, must adhere to the wing and not become turbulent or detach from the surface of the wing before it can be diverted downward at the trailing edge. There are many theories of lift, some traditional, some imaginative and seemingly intuitive. However, in recent years most of the traditional theories have been discredited as they were found to be flawed, entirely improbable or simply wrong as aeronautical knowledge and understanding has progressed. It is most likely that there are numerous ways in which a wing produces lift. The airfoil as a downwash "air diverter" at the trailing edge is and has for a while been what this writer thinks is the most probable correct theory. Of course, the true scientific mind must always be open to new facts and disclosures. This writer awaits with great interest what is yet to be discovered.

Also, a smooth and adherent boundary layer produces minimum pressure and/or parasite drag enabling the aeroplane to

fly faster for any given amount of power. Slight micro-turbulation in the boundary layer actually increases its adherence to the surface of the wing; but, when this turbulation becomes more severe and becomes a turbulent flow, lift is reduced and pressure drag increases. If this turbulence becomes too severe, which typically happens at critical positive Alpha, the turbulent boundary layer detaches from the surface of the wing creating random eddies and vortices causing considerable parasite and pressure drag to be produced. Upon boundary layer flow separation from the surface of the wing the former downward diverted air flow ceases and, concurrently, the wing ceases to generate lift. This is the "stall".

An airfoil designed to produce maximum uninterrupted, adhesive boundary layer flow at the surface of the wing and minimum drag by moving the thickest part of the airfoil back to the 40-50% point is called a "laminar flow airfoil".

NACA NUMEROLOGY

The first number, "6", of NACA 64(2)-A215 (the Comanche's airfoil) indicates that this is a NACA "6-series" airfoil. The second number, "4", indicates the position in percentage x 10 of the chord (leading to trailing edge) where minimum pressure occurs — here indicating the 40% chord position. Minimum pressure usually occurs at the thickest part of the airfoil. The subscript "2" indicates that this airfoil's Cd (coefficient of drag) approximates its minimum value between plus or minus 0.2 of the airfoil's design Cl. (coefficient of lift). The NACA 65(9)-415 airfoil which was used for the Cherokee is a later refinement of the

Comanche's NACA 64(2)-415. The only significant difference between the Cherokee's airfoil and the Comanche's is that in the Cherokee's airfoil the Cd approximates its minimum value between plus or minus 0.9 of the airfoil's design Cl while the Comanche's Cd approximates its minimum value between plus or minus 0.2 of the airfoil's design Cl. The next number "2" indicates the lift coefficient in tenths; here, 0.2. The last two numbers, "15", indicate the wing's maximum thickness as a percentage of the chord; here, 15% of the chord. A laminar flow airfoil is typically designed so that its thickest point is usually at approximately 40-50% of the chord. A normal airfoil's (Bonanza's) thickest point is usually at approximately 25-33% of the chord. The laminar flow airfoil shape combined with a very smooth wing surface best promotes a smooth and adherent boundary layer fostering higher airspeed capability.

COMANCHE DESIGN

The North American P-51 "Mustang" was the world's first purely mathematically designed aeroplane and its wing was the first to be deliberately designed with a "laminar flow" airfoil. However, even a very slight ripple or bump in or on the surface of the wing will prevent the true laminar flow effect. Despite all good intentions what with numerous hatches and doors and such for the maintenance of guns, reloading of ammunition and the like the P-51's wing surface as manufactured is not sufficiently smooth and uninterrupted nor was it optimally built or sufficiently maintained to be clean in the field to promote true laminar flow. The Comanche's wing surface, however, is actually far smoother and if kept scrupulously clean, promotes a stable, adherent boundary layer very well. A salient characteristic of the Comanche's airfoil is that it has a fairly flat Cd curve right up to the stall and thereby loses lift very slowly as the stall is approached, although not to the extent as does the Cherokee with its slightly more advanced laminar flow shape. Also, the Cherokee's airfoil does not possess a single critical angle of attack (positive Alpha) at which it will stall. The Comanche's NACA 64(2)-415 airfoil flies within a fairly broad range of positive Alpha (limited only by the wing's aspect ratio as discussed below) and does

not break very sharply at the stall unless very aggressively forced into an extreme positive Alpha condition called a “deep stall”. Spins are likewise difficult to enter unless aggressively pursued.

Another design feature that is an innovation, at least and certainly for Piper in the late 1950s, is the Comanche’s high aspect ratio (AR) wing at 7.53 (see calculations below). The AR is the mean chord (measured from the leading to the trailing edge) divided into the overall wingspan (which includes the width of the fuselage). The average AR for GA single-engine aeroplanes is between 5 and 6. That is the chord is 1/5th or 1/6th the span. AR lower than 5 is considered to be in the low AR range and above 6 to be in the high range.

For wings that are tapered (not rectangular) as is the Comanche’s wing, the AR is calculated as the square of the span divided by the wing area. $AR = \text{span}^2 / \text{area}$. The Comanche’s wingspan is 36 ft.

and its area is 172 sq. ft.

Span squared divided by the wing’s area = aspect ratio

Span- 36 (sq.) = 1,296 wing area=172; accordingly, $1,296/172 = 7.53$.

This is a rather large AR which gives the Comanche’s wing specific characteristics.

A higher AR wing is more efficient than a wing of the same area but with a lower AR for the following reasons:

As discussed above lift is primarily a product of downwash at the trailing edge. Where there is more clear trailing edge available to produce downwash, more lift will be produced.

The wingtip and its proximate area produces little to no lift and produces a strong drag - producing vortex caused by the high air pressure below the wing swirling into the lower air pressure above the wing, all of which is called “tip effect”. The force and depth tip effect into the wingspan on wings of approximately the same area (but

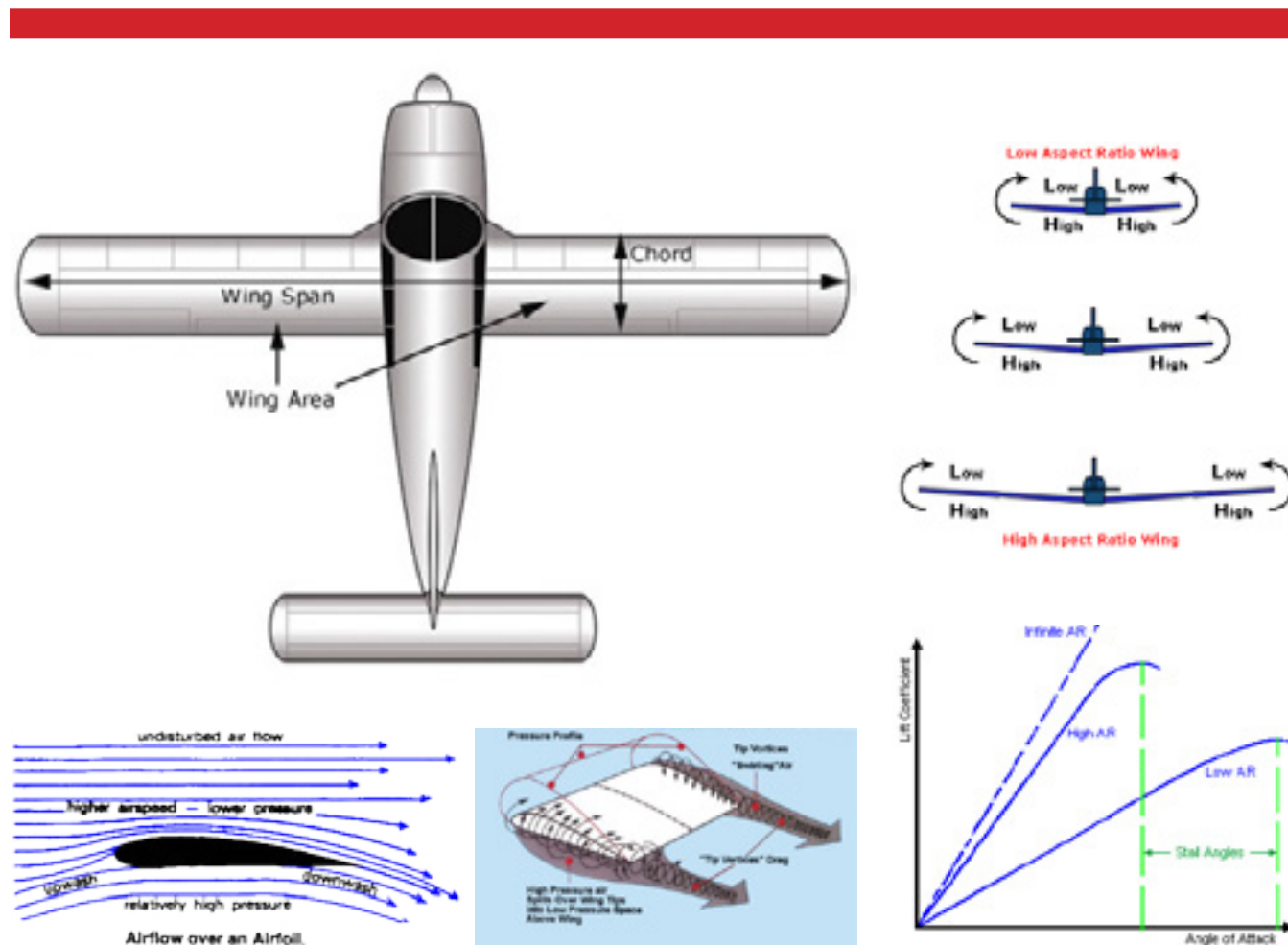
not necessarily of the same AR) is roughly equal.

Accordingly, the greater the distance the tip of the wing and the resulting tip effect is from the wing root the greater the clear span of lift-producing trailing edge and lesser the relative tip effect on the entire wing.

As shown, the tip effect is approximately the same regardless of the length of otherwise similar wings. Accordingly, the higher AR wing is less negatively affected by tip effect than the lower AR wing increasing the efficiency of the higher AR wing.

Additionally, as the AR increases the CL increases and less Angle of Attack (Alpha) is required to produce lift, increasing efficiency once again.

However, the graph above also indicates that higher AR wings stall at a lower Alpha. This means that the higher the AR of the wing is the less useable positive Alpha it has.



DYNAMIC ELEGANCE



Radio controlled Curtiss Robin model popular for sailplane towing. Note the average aspect ratio of the wing.



5- Metre Discus R/C sailplane. Note the extremely high aspect ratio of the wing.

A PRACTICAL DEMONSTRATION OF THE EFFECTS OF ASPECT RATIO

This particular principle of aspect ratio was illustrated to me in an interesting and clearly demonstrative way one day a few years ago when I was visiting some friends at a local radio-controlled (R/C) model aeroplane field. Some of the pilots had large un-powered sailplanes which they would get up to thermal (where the air has natural lift) altitude by having another pilot aero-tow it. The sailplane had a radio-controlled towline release mechanism when the sailplane pilot was high enough.

The tow aeroplane was a very large and sturdy, a sort-of-scale Curtiss Robin with a 96" (8') wing and a powerful 62cc gasoline engine with a 22x10" propeller. The AR of the Robin's wing was average, the average chord approximately 17 1/2", 5.5 of the span. However, the sailplanes were all between 4 meters (13.12') and 5 metres (16.40') and had very high ARs of 20-30; that is, their very narrow chords were between 6 and 7 1/2".

The tow pilot was a very good R/C pilot but he had no previous experience towing sailplanes. One of the larger sailplanes, a gorgeous 5 metre Discus, hooked up to the 30 foot towline and off they went without incident, for a few minutes anyway. That majestic sailplane being towed by the powerful Robin looked very like a full-scale operation. They settled into a nice, smooth

coordinated flight, constantly communicating to each other and then the tow pilot began the climb to altitude. He climbed at his usual angle at full power with plenty of airspeed for the sailplane. However, as soon as the Robin pitched up and began to climb the sailplane behind it began to stall and the tow line pulled down sharply on the tail of the Robin which had been climbing with no trouble.

Baffled, the tow pilot levelled off and the sailplane began to fly again. Once again the tow pilot began his usual climb and once again the sailplane stalled out behind the tow aeroplane and once again the tow pilot levelled off. The sailplane pilot and the tow pilot were in a conversation as to what was going on. The tow pilot said that he was intentionally climbing at a good airspeed to prevent the sailplane from stalling, and in any event, the sailplane's stall speed was far lower than the heavy Robin's.

Watching carefully I thought that I understood what was happening and I suggested to them that the tow pilot climb at more moderate angle. He did this and he was then able to tow the sailplane up until it was very small. The sailplane pilot then disengaged, went looking for thermal lift and the tow aeroplane came down for a landing.

After the sailplane had flown for at least a half-hour, the sailplane pilot brought it down for a graceful landing. The tow pilot

and sailplane pilot asked me what had happened and why the normal climb did not work and the moderate climb worked. I explained about high and low ARs and stall Alphas, etc. The tow aeroplane with its average AR could climb at fairly high Alpha while the sailplane could only climb at a fairly low Alpha. Once the tow aeroplane reduced its Alpha the sailplane could climb behind it with no trouble.

In its time, the new Comanche was overall a very aerodynamically clean design with the exception of the engine cowl intake openings which are, typical of similar aircraft of the late 1950's, unnecessarily large, creating unnecessary drag from excessive air entering the cowl. This inefficient, airspeed robbing cowl design is also found on the Mooney M20 and many GA aircraft designs of the late 50s and 60s, including to a slightly lesser degree, the Bonanza.

While a trailing link style undercarriage, found in both Mooney and Beechcraft aircraft, is a pilot-friendly and well-proved design, Piper's engineers, ever vigilant about keeping down the Comanche's selling price, designed a simpler, straight, oleo tube undercarriage for the Comanche. As aircraft incorporating this kind of less forgiving undercarriage require more refined piloting skills to make soft landings, Comanche pilots who can do so justly own some bragging rights over Mooney and

Beechcraft pilots.

Full, dual controls (except initially for right toe brakes) as in all previous Piper aircraft were incorporated into the Comanche as well. Piper believed that this would be better received than the Bonanza's single throw-over control column which was a curious throwback to the 1930/40's era Beechcraft Staggerwing and other aircraft of that era, and which was often popularly criticised. Of course, Beechcraft did not anticipate that the Bonanza would be used as a trainer and felt that a single throw-over wheel, leaving the front passenger seat completely unobstructed was the best design for a business aeroplane. BTW, the throw-over wheel makes getting checked out in a Bonanza with this feature a bit of a chore.

For the sake of further simplicity and manufacturing familiarity, the flaps would be manually operated by a central flap handle as in the Tri-Pacer, the elevator trim likewise operated by an overhead horizontal crank (see below), and toe brakes would be available only on the pilot's rudder pedals (although a kit for retro-fitting a second set of toe brakes would soon be made available). The decision that the first new Comanche would be powered by the 180 hp (134 kW) Lycoming O-360-A1A engine was a curious one, given that the 1957 H35 Bonanza with which Piper was competing had a 240 hp Continental O-470-G engine giving the Bonanza a Beechcraft "published" 75% cruise of 165kts at 7,500'.

An interesting but little known fact about the design of the Comanche is that Piper used a few common automotive items on the aeroplane one may suppose for economic reasons and perhaps in order to make it more customer-friendly.

One of these items is the interior door handle. The 1958-60 Comanche handles appeared to identical to those used in 1956-66 Studebakers, later Comanches used interior door handles from the 1967 Ford Falcon or Fairlane. Another, later Comanche door handle is from Volkswagon and is a small handle that is recessed into the door and is pulled back to open.

Not only did Piper apparently use automotive parts for interior door handles, they also used a 1956 Studebaker window crank for the overhead elevator trim control on earlier Comanches, before the

elevator trim control was moved to the floor between the seats.

By January 1958 the first Piper PA-24-180-Comanche was delivered to the public. Its price was a rather modest (for an aeroplane of this quality) \$14,500.00 (\$118,708.84 in 2015), but it was not the aeroplane that Piper knew it had to build to compete with the more powerful (240 hp) Bonanza. The Comanche 180's useful load was a respectable and competitive 1,020 lbs., actually 166 lbs. greater than the Bonanza H35, and its cruising speed at 75% at 8,000' was 139kts which is excellent for a 180 hp aeroplane, but it was not nearly fast enough to seriously compete with the Bonanza.

CATCHING THE BONANZA

At all times fully aware of the 240 hp H35, Piper began to immediately test the installation of a 250 hp Lycoming O-540 engine in the Comanche. The PA-24-250 was introduced in April 1958 and had a 75% cruise speed at 7,500' of 160 KTS and a useful load of 1,110 lbs., now 246 lbs. greater than the H35.

As Piper had so meticulously planned, the Comanche 250's 1958 basic price of \$21,250.00 (\$173,969.85 in 2015) was just a bit less than the basic price of a contemporary Beechcraft H35 which was \$22,650.00 (\$185,431.40 in 2015). One might truly say that even if the 1958 Comanche 250 was slightly slower than the Bonanza H35 according to Beechcraft's claims (and this is definitely not necessarily so), the difference in cost between the two aeroplanes certainly did not justify the Bonanza's higher price.

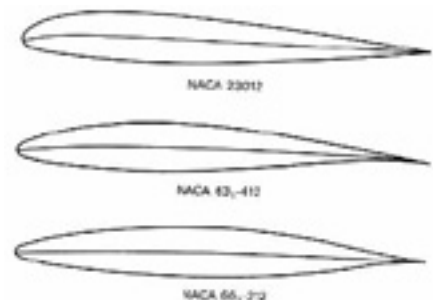
Given its very competitive and excellent specs and distinct advantages the choice of the Comanche 250 was (and still is), for most prospective owners a "no brainer". What the less expensive Comanche 250

offers over the Bonanza H35 is a higher useful load, a wider, more comfortable cabin, dual controls and, most importantly, more stable handing, particularly at lower airspeeds and without the need for a down spring on the elevator control system! What William Piper had wanted from the Comanche and what he got was a high performance aeroplane with such solid aerodynamics that even low time pilots could confidently move up to and safely fly.

Regarding a comparison of airspeeds, with all of its advanced aerodynamics, particularly its laminar flow airfoil, at most altitudes the Comanche 250 easily matches or betters the speed of a similarly powered Bonanza. While practical experience with both aircraft proves this to be true (see below), it runs contrary to Beechcraft's advertised airspeeds for the Bonanza. However, many believe that Beechcraft's published airspeeds are inflated and were possibly recorded when the Bonanza was very lightly loaded and, of course, any aeroplane will fly faster when lightly loaded as the power loading is reduced.

Each aeroplane has its particular aerodynamic advantages and disadvantages. The Bonanza's advantages are a thinner wing which is small for the aeroplane's weight, a slightly narrower, round profile fuselage, and a slightly cleaner cowl-ing. The Bonanza's main undercarriage is fully enclosed with secondary doors when retracted while the Comanche's main undercarriage is partially exposed to the airstream and the Bonanza's flap hinges are internal while the Comanche's are exposed to the airstream. However, the Bonanza's wing's airfoils are a traditional NACA 23000 series where maximum thickness is a traditional 25-30% of chord (see below).

The top airfoil is almost identical to the Bonanza's root airfoil. The centre airfoil is close to the Comanche's airfoil and is of a laminar flow design. The bottom airfoil is a more extreme laminar flow airfoil, most often seen on military jet aircraft.



DYNAMIC ELEGANCE

Taken altogether, except for its wing's airfoil, the Bonanza's airframe is just a bit cleaner than the Comanche's. However, the Comanche is generally as clean as the Bonanza, except for the above, but it has one great advantage as said; the Comanche's wing has a laminar flow airfoil (see diagram above), giving it a distinct air-speed advantage.

Additionally, as altitude increases and the air begins to thin out, the advantage of aerodynamic cleanliness begins to dwindle. A good example of this is a comparison of the high altitude performance of the P-51D "Mustang" and the P-47D "Thunderbolt". While the compact and far sleeker Mustang is much faster than the larger and draggier Thunderbolt at similar power settings at low to middle altitudes (up to 20,000'), at the similar power settings the Thunderbolt easily catches and passes the Mustang above 32,000'.

Similarly, published performance specs notwithstanding, the Comanche begins to gain on and exceed a similarly powered Bonanza at or above 16,000' leading to the widely held opinion that all Comanches ought to be turbocharged so that they may best take advantage of their excellent already built-in high altitude efficiency.

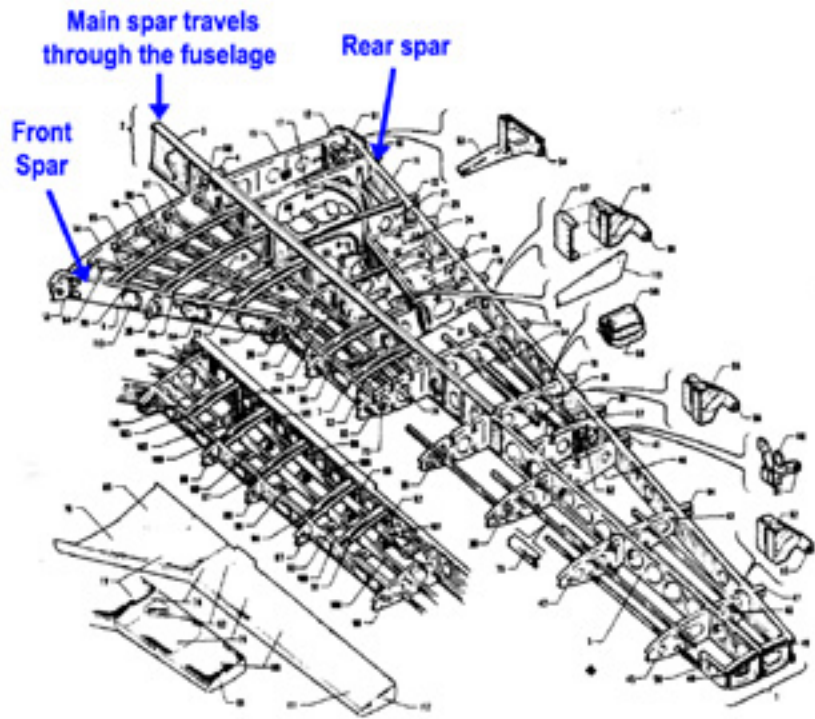
The Comanche's higher AR wing is also longer than the Bonanza's by 3' 2" which is a substantial difference in wings of these spans (see specifications charts below). The Bonanza's shorter wing presents a smaller frontal area and therefore less drag than the Comanche's longer wing. However, this is offset, as said, by the Comanche's laminar flow airfoil as compared the Bonanza's traditional airfoil.

The Comanche's higher AR does not increase its airspeed but its efficiency permits a greater useful load, faster rate of climb, shorter takeoff and climb to 50' distances and gentles its low-air-speed (high Alpha) and departed flight regime (stall/spin) as compared to the Bonanza's far less forgiving low airspeed and departed flight regime (remember that down spring).

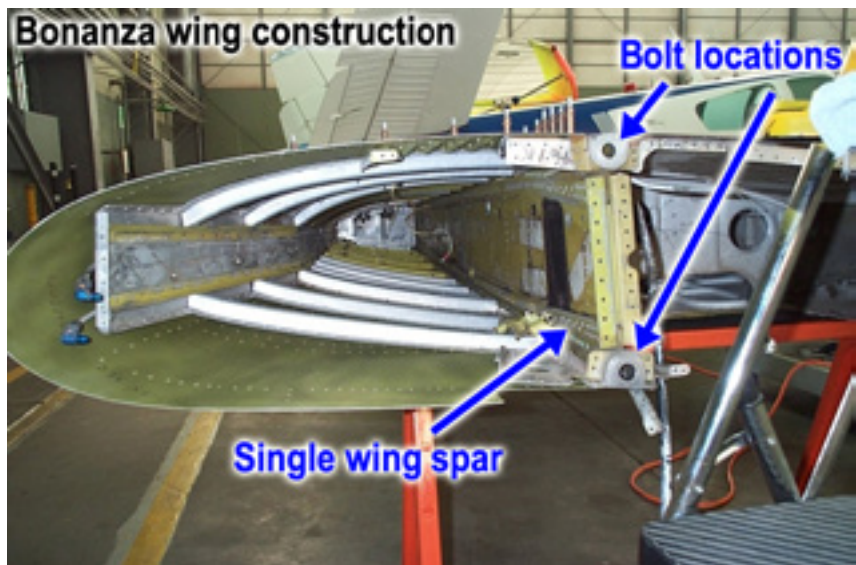
So it appears that the Comanche's and the Bonanza's aerodynamic advantages and disadvantages cancel each other out for the most part with the Comanche having a slight edge over the Bonanza despite Beechcraft's apparently exaggerated airspeed claims.

One feature Piper was not at all

Piper Comanche 250 wing construction



Bonanza wing construction



Bonanza wing bolt

DYNAMIC ELEGANCE



Business and range are the key selling points here.



Finally, some fun with the family at an exotic vacation spot. Piper usually combined other Piper aircraft in one advertisement. Here we also see an Aztec twin and early Cherokee.



The entire Piper line is shown but the Comanche is most prominently placed in this ad.

reluctant to point out, is the design of the Comanche wing itself. From a Piper Comanche advert:

"Massive quality construction: Look at the Comanche's deep, 12-inch spar, check construction throughout and you'll see why the Comanche has such a magnificent structural safety record."

If we take a closer look at the wing internally, the Comanche's main spar is at the 50% chord position, travelling into and through the main cabin and passing under the rear seat which provides the rear passengers with a comfortable, flat floor. Additionally, the Comanche's wings have two sub - spars, fore and aft which are joined together at the factory as one piece which is then mounted to the fuselage. The result is an incredibly strong wing.

By comparison, the Bonanza's wing has its main spar at approximately the 25% chord point and there is no other equally robust sub spar. Also, the Bonanza's wings are bolted to the fuselage independently as separate units.

On this page and the previous page is a selection of Piper advertisements which give some insight as to how Piper marketed the Comanche.

AND THE WINNER IS...

It is a ubiquitous trait of the human personality to wish to bring down that and those who stand at the top of the mountain. As children we play the game "King of the Mountain" in which this what we try to do and it all seems to us to be a most natural endeavour. Generally, people are especially unhesitant and glad to tear down that thing or person which or who has proclaimed itself to be "best." This is understood and herein acknowledged. With this in mind I have tried to be most careful and judicious before casting aspersions. Still, it is not at all unfair to subject the "King", particularly one which is self-proclaimed, to be the subject of careful scrutiny and assessment to see if such an exclusive and superlative accolade is well-earned and deserved. This may be a particularly American (and Commonwealth, etc.) attitude given our fundamental anti-aristocratic genesis and culture, but it is not, I think, an exercise that lacks merit by anyone or at any time. After all, how else may we accurately judge the value and validity of such claims?

In 1957 William Piper sought to harness and apply the most modern aeronautic



While more modest in its advertising campaign than Beechcraft, Piper was not shy about clearly pointing out what made the Comanche so good.

science available in his passionate quest to build the “best” GA aeroplane he could and to throw down the King of the Mountain, the Beechcraft Bonanza and to replace it with the Comanche. The name “Comanche” itself may have been deliberately and complimentary chosen by Piper given that the actual Comanche Nation was a noble, powerful, fierce, feared and dominant tribe in the southwest part of what became the United States.

I think that it is safe to assume that before Piper began the Comanche’s design phase that the engineers at Piper Aircraft analysed the Bonanza from nose to tail and wing tip to wingtip. They surely flew it for countless hours and took careful notes of its best and worst characteristics. The result was the Piper 1958 Comanche 250, purpose-built to beat the Bonanza at its own game. Well, did Piper succeed?

ONE PILOT’S STORY

The “Sky Roamers” has been a popular flying club since the 1950s. It owns 22 aeroplanes, has 250 members and is based at “Bob Hope Airport” in Burbank, California. In 1958, Robert Wall, a retired

U. S. A. F. pilot became the chief pilot for the club. Just after he took his position at the club the Sky Roamers began to think about purchasing its first aeroplanes with a retractable undercarriage. After much discussion the choice came down to two, the 1957 H35 Bonanza and the 1958 Comanche 250.

Mr. Wall recalls, “We were looking to buy four retractables, so the stakes were pretty high. We decided to test the two representative models available at that time. On paper, the airplanes were pretty evenly matched, 240 hp in the Bonanza, 250 hp in the Comanche,” he says.

The club discussed a fair test for the aeroplanes. “We decided to fly an out-and-back from Burbank to Phoenix with four people in each airplane and fuel to gross weight. Mr. Wall reports, “The Comanche was the winner in almost every category hands down. Everyone loved the way the Bonanza handled, but the Comanche out-climbed the Bonanza at all altitudes and out-ran it at all power settings. I was impressed. Eventually, the club wound up buying four Cessna 210s instead of the Comanches, and that turned out to be a big mistake.”



Speaking about his personal choice for an aeroplane Mr. Wall says, “I finally found my ideal airplane, a nice 1958 Comanche 250, up in Minnesota in 1983 and decided that was the one I wanted. It’s far more stable than the others, it’s about the same speed or perhaps a little quicker than the Bonanza, but it will carry far more than the V-tail of the same vintage and horsepower. And it certainly didn’t hurt that it was less expensive than the Bonanza or most anything of comparable horsepower on the market.”

So, did the Comanche actually kill the Bonanza or ever take its place at the top of the GA food chain? Well, maybe in some eyes it should have, but the answer

is clearly, no. The Beechcraft Bonanza has remained at the top of GA aeroplanes and has become a veritable institution. However, the Comanche did compete well with it and better in that regard than anything else in its time. Piper and Beechcraft continued to strive with each other until the Comanche suddenly ceased production in 1972, along with the excellent, sleek and speedy Twin-Comanche. The “official” reason for this is the result of catastrophic damage to Piper’s Lock Haven, PA factory caused by the record rising of the nearby Susquehanna River due to Hurricane Agnes. As to the real reason for Piper ceasing the production of these fine aeroplanes, speculation and rumours abound.

DYNAMIC ELEGANCE

Mr Wall is not the only one, nor is he merely one of a small group of pilots who have discovered that the Emperor Bonanza has no clothes or is at least in need of a serious make-over. Herein I have been more than slightly critical of the Bonanza on a number of levels and in each of such instance have done my best to show why what I have written is not merely opinion, biased or otherwise. Still, we at A2A have been and are reluctant to cast aspersions, even those which have been well-earned, upon any aircraft manufacturer or aeroplane. We love aeroplanes and those who make and fly them.

That said, I don't think that I'm telling any tales out of school when I report that Scott and I have been batting around such criticisms which I have been made regarding Beechcraft's published performance claims for the Bonanza and particularly in reference to a Comanche of equal power. We asked: Are we being too tough? Are we biased? Are we being fair? And, the ultimate, unavoidable question: Are we telling the whole and unvarnished truth?

Well, after much discussion we came to the realisation that the only way to discover the truth, notwithstanding decades of other pilot's testimony, was to do a real-world flight test of a Bonanza flown at equal power to the Comanche and see what the numbers show us.

On the afternoon of June 6, 2015 Scott went flying in a E-33A Bonanza. This aeroplane has a standard cruciform tail and a 285 h.p. engine. Given that there exists no evidence on record that a V-tail adds or subtracts from the airspeed of a Bonanza, we did not see the standard cruciform tail as a problem. The higher powered engine in the Bonanza was easy to work with and power settings were set during the flight which equalled the power of the Comanche's 250 h.p. engine.

The results are (drum roll): The Bonanza was loaded 500 lbs. under maximum gross weight with three on board, two in the two front seats and Captain

Jake (Scott's son) in a rear seat. It is a more cramped side to side inside than the Comanche but has impressive headroom. The outside air ventilation was discovered to be far less effective than the Comanche's. The Bonanza, even loaded as lightly as it was and with more power available does not climb as well as the Comanche at maximum gross weight by many hundreds of feet per minute. I attribute this, in part, to the Comanche's more modern laminar flow airfoil and even more to the higher aspect ratio of the Comanche's wing.

Airspeed tests were made at 6,000' with the power adjusted, as said, to match the power of the Comanche at that altitude. Even taking the lower weight of the Bonanza on this flight into consideration, it never was able to equal by many knots the airspeed of the Comanche or even its own published "official" performance specifications.

When approaching a 1-G stall in the Comanche a warning light starts blinking along with airframe buffeting with increasing intensity as the stall approaches. It literally slaps the pilot on the back and clearly indicates (shouts) as if to say, "Alright, get ready, were going to stall very soon unless you unload the wing by pushing forward on the yoke." If during this the yoke is held all the way back the Comanche will finally stall with a moderate break and a wing will drop, which is instantly recoverable by releasing back pressure on the yoke.

Doing the exact same maneuver in the Bonanza, there is an audible warning that sounds well ahead of the stall, but the aeroplane continues to fly smoothly right up to point just before the stall, then there is a brief airframe rumble then an immediate, precipitous stall with a sharp wing drop. In the Bonanza there is no long period of buffeting as you approach the stall. Interestingly, and quite satisfyingly for an old aerodynamicist like me, this actual, real-world departed flight behaviour exactly matches the polar of the Bonanza's

23000 series airfoils wherein the Cl steadily rises right up to the point of stall Alpha and then drops off sharply at the stall break. Recovery, however, is not a problem and is much like that of the Comanche. Both the Bonanza and Comanche rapidly accelerate back to cruise speed. Intentional spins are not permitted in either the Bonanza or the Comanche so there were no tests in that area; however, the Bonanza felt more likely to spin out of an ordinary 1-G stall.

To the Bonanza's credit, its trailing link undercarriage feels far more substantial and smooth upon landing than does the Comanche's straight oleo strut. Bonanza's abrupt and sharp stall characteristics generally lead pilots to carry around approximately 1,200 r.p.m. when landing until touchdown.

Between these two aeroplanes, as to performance in every category as well as all of the other features mentioned, A2A's real-world flight test shows that the Comanche, except for its undercarriage design, is the clear winner on every count.

Today, as newer and even sleeker modern composite designs vie with each other and with the latest version of the venerable, old Bonanza for top dog in the GA high-performance, single-engine market, the Bonanza lives on, albeit since 1982 when the last V-Tail Bonanza was built, in the shape of the venerable, reliable old Debonair and is still in production with no end in sight.

While its time in the market as a new aeroplane was relatively short 14 years (1958-72), since its introduction the Piper Comanche has been and still is one the most highly-respected and desirable GA aeroplanes of all time and a good one in good condition is considered a prime find on the used aircraft market. Today there are many thousands of loyal Comanche adherents who firmly believe as I do, and if I say so, with good reason that it is the most beautiful, elegant and overall best performing single-engine

GA aeroplane ever built. Right, Scott?

Lastly, let's take a look at how Piper marketed their corporate image. Always highly photogenic, it's no surprise that the Comanche was chosen to represent the entire Piper fleet.



PIPER COMANCHE, HOLDER OF THREE OFFICIAL NON-STOP WORLD DISTANCE RECORDS

INTEGRITY

We build Piper airplanes on the assumption that you're going to fly them "forever."
This means building with integrity. Integrity in design...integrity in construction.

You see it in the Piper family look. Every Piper model, from the hard-working Super Cub to the dynamic Aztec, has a look of sturdy dependability, stemming from an unyielding Piper philosophy that says, "Performance must go hand in hand with strength, stability, safety and value." The result is an amazing amount of "flyability" in Pipers. They simply want to fly.

Of course, there's a lot of integrity in your Piper that you don't see. You just profit by it. To help you fly your Comanche, Apache, Twin Comanche or Aztec "forever," all aluminum surfaces are zinc chromated—inside and out—before assembly. This is worthwhile protection for your valuable airplane. Other manufacturers offer it as an extra-cost option, some not at all. Piper just goes ahead and does it—because it should be done for aircraft in this class.

These same Piper models have their main spar running right through the fuselage on the solid "beam construction" principle, not joined at the sides of the fuselage, as on some aircraft. In the same manner, the more effective horizontal

stabilizers of these Pipers have a hunky steel tube that goes through the fuselage, for enormous strength and durability.

A typical example of Piper structural strength can be seen in the evolution of the Cherokee series. With the addition of more powerful engines, the Cherokee gross weight went from 2150 lbs. to 2400 lbs. with no changes in the airframe whatsoever. Then came the Cherokee 235, beefed up to support this heavier power plant, but still the same basic airframe, now grossing 2900 lbs.! This "strength to spare" pays off in long years of dependable service.

Piper engineers are fanatical about the landing gear—because an awful lot rests on those three wheels. For instance, they just can't see putting an undersized nose gear on any airplane. That gear has to bear the weight of the engine, on landing after landing. It has to keep the prop clear of the ground on rough terrain. That's why there's nothing delicate about a Piper nose gear. That's why Piper nose wheels are the same size as the main wheels.

Would you want it any other way?

It's a matter of Integrity. Some of it you can see on a Piper, some of it you can't. We'd certainly like to have you visit our main factory at Lock Haven, Pa., and see every bit of integrity that goes into our Super Cubs, Pawnees, Comanches, Twin Comanches, Apaches and Aztecs. Or, if you're in Florida, see our Cherokees assembled at Vero Beach.

If this isn't handy, see your Piper dealer. He'll be glad to tell you about all the things we couldn't cover in this space, including some interesting specifics about Piper value.

Your Piper dealer knows about Piper integrity. He's part of it.



PIPER
AIRCRAFT
CORPORATION
Lock Haven, Pa. (Main Offices)
Vero Beach, Fla.

MORE PEOPLE HAVE BOUGHT PIPERS
THAN ANY OTHER PLANE IN THE WORLD

DEVELOPER'S NOTES





WELL, WE FINALLY DID IT – we created an Accu-Sim version of the A2A 1959 Piper Comanche 250. At first we thought, considering I am personally close to this plane, reproducing all of the slight nuances was going to be overly taxing on our team. But like prior projects, having full access to the aircraft allowed us to dig deeper to simulate those subtle, but very important nuances that otherwise may be missed. But now with the project completed, it feels every bit like my very own airplane is now inside my computer, in this amazing virtual world we call “Accu-Sim.”

Out of so many great features, one of the most exciting one to me is the new “Aircraft DNA” technology that allows us to capture and reproduce almost every tremor a real airplane produces. We’ve also been able to develop an even deeper experience of what it’s like to lean an airplane in the air. Your ears and seat of the pants, is so important in the real plane, and now Accu-Sim delivers this experience even more. We are very happy with the results, as this pushes the simulation even deeper into the heart of the airplane.

If you ask me, the Piper Comanche may be the very best high performance, complex, single-engine airplane ever made. As an owner of the Comanche for three years, I am yet to find a serious vice. It feels like a small fighter to fly, has more room than almost any plane in its class, can carry a heavy load, is rugged, has attractive lines, and can fly both fast and far.

The 36 foot wing (38 feet with tip tanks) is the jewel in the Comanche crown. If you look at the internal spar construction, you will see the heavy influence from military airframe design. And the latest development is the brand new, modern composite prop from MT Propeller, which just seems to fit so well with the Comanche airframe. The Comanche has that beautiful long nose, nice 3-blade prop, sturdy airframe, and powerful engine. What more could you ask from an airplane? After three years, all I can think of is how lucky I’ve been to own and operate this plane.

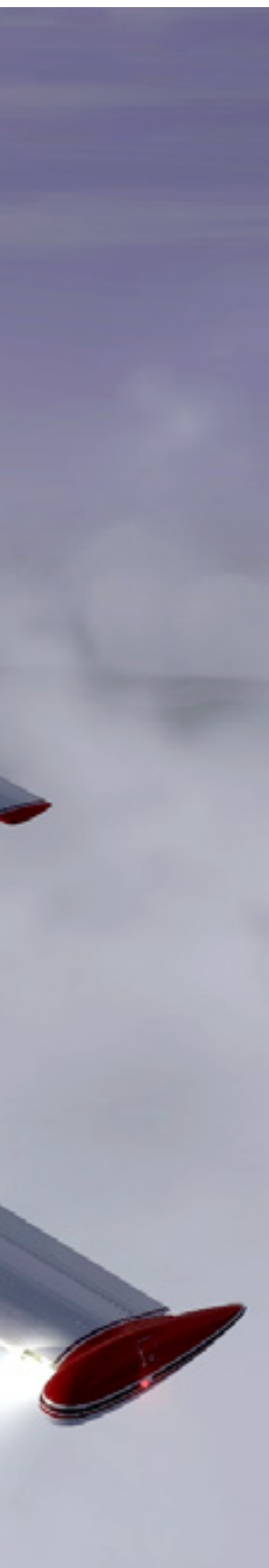
Well, somehow we brought all of this genuine realism into the simulation; however the team did work over time to make this happen. You can now experience flying this aircraft in a simulation, unlike anyone has ever experienced before.



THE AIR TO AIR SIMULATIONS TEAM

FEATURES





- ✧ Aircraft DNA technology re-creates actual engine and airframe vibrations
- ✧ 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 O-540 engine. Now the gauges look beneath the skin of your aircraft and show you what Accu-Sim is all about.
- ✧ Authentic Avionics stack with authentic. Three in-sim avionics configurations including no GPS, GPS 295, or the GNS 400. Built-in, automatic support for many popular 3rd party avionics.
- ✧ STEC-30 Autopilot built by the book.
- ✧ 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.
- ✧ Ten 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 Comanche 250. 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 Comanche 250 Trainer requires the following to run:

- Requires licensed copy of Lockheed Martin Prepar3D

OPERATING SYSTEM:

- Windows XP SP2
- Windows Vista
- Windows 7
- Windows 8 & 8.1

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

QUICK-START GUIDE

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 on the right.

REALISM SETTINGS

The A2A Simulations Accu-Sim Comanche 250 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 Comanche 250.

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

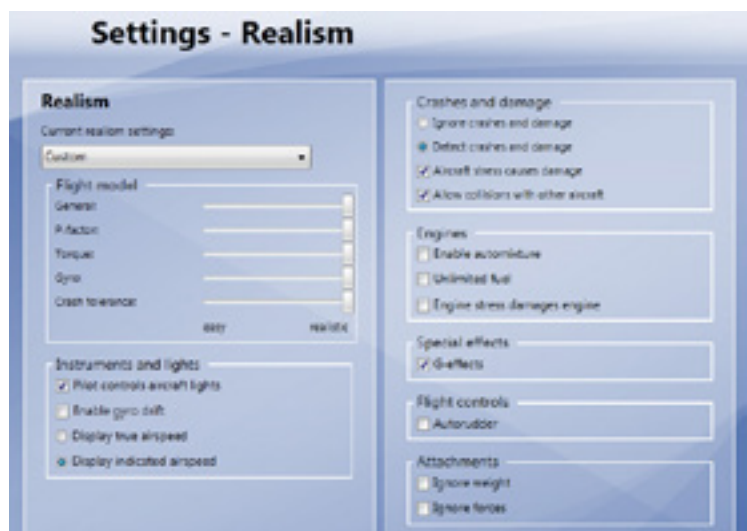
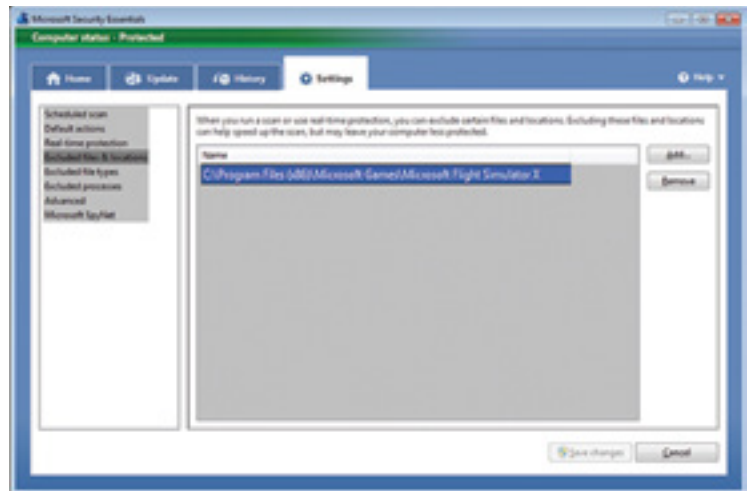
Ensure “Enable auto mixture” is NOT checked.

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

It is recommended you have this **UNCHECKED**.

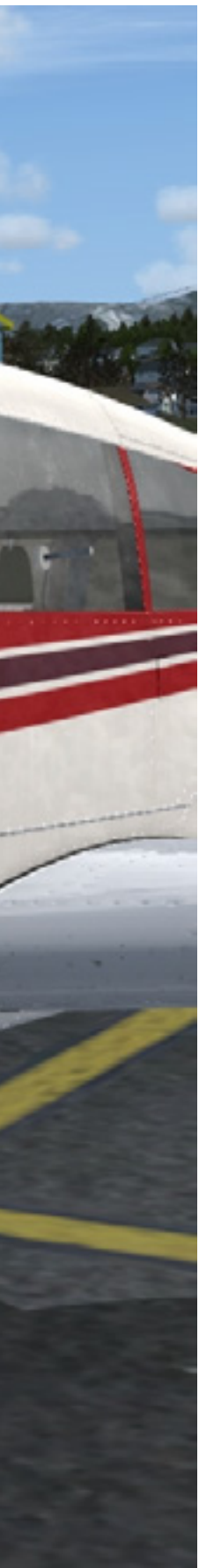


QUICK FLYING TIPS

- ✧ 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.
- ✧ On landing, once the airplane settles slowly pull back on the yoke for additional elevator braking while you use your wheel brakes. Once the airplane has slowed down you can raise your flaps.
- ✧ Be careful with high-speed power-on dives (not recommended in this type of aircraft), 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 a Simulation Rate higher than 4x may cause odd system behavior.
- ✧ A quick way to warm your engine is to reload your aircraft while running.
- ✧ In warm weather, use reduced power and higher speed, shallow climbs to keep engine temperatures low
- ✧ Avoid fast power reductions especially in very cold weather to prevent shock cooling the engine

ACCU-SIM AND THE COMANCHE 250





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 Comanche 250 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 window 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 pressure. 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 100psi.

PERSISTENT AIRCRAFT

Every time you load up your Accu-Sim Comanche 250, you will be flying the continuation of the last aircraft which includes fuel, oil 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 Comanche 250 and includes engine sputter / spits, bumps and jolts, body creaks, engine detonation, runway thumps, and flaps, dynamic touchdowns,

authentic simulation of air including buffeting, shaking, broken flaps, primer, and almost every single switch or lever in the cockpit is modeled. 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.

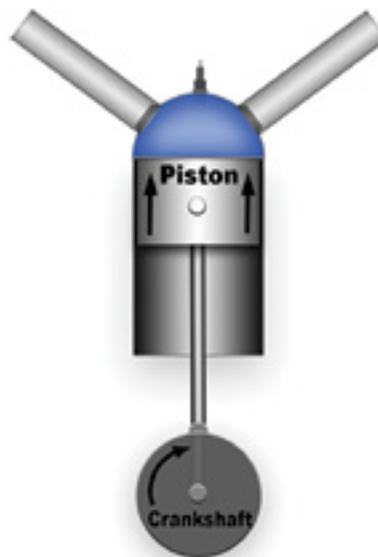
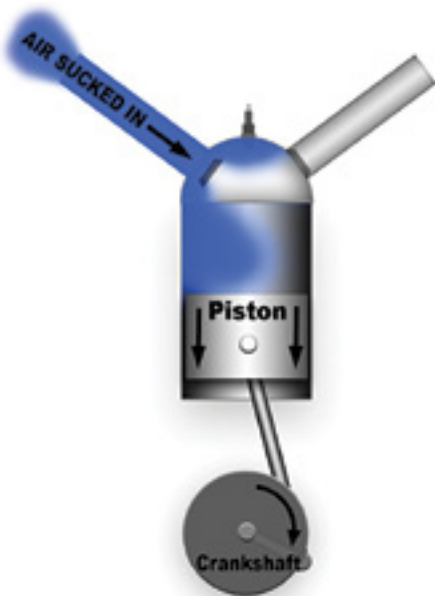
Accu-Sim watches your landings, and the moment your wheels hit the pavement, you will hear the appropriate sounds (thanks to the new sound engine capabilities). Slam it on the ground and you may hear metal crunching, or just kiss the pavement perfectly and hear just a nice chirp or scrub of the wheels. 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 Comanche 250. 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.



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 its 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.

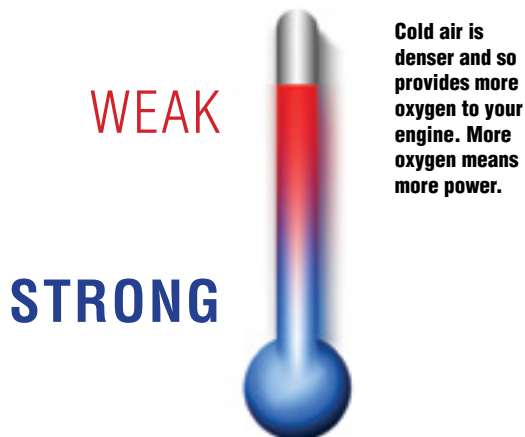
The piston pulls in the fuel / air mixture, then compresses the mixture on its way back up.

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ACCU-SIM AND THE COMBUSTION ENGINE

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.



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:

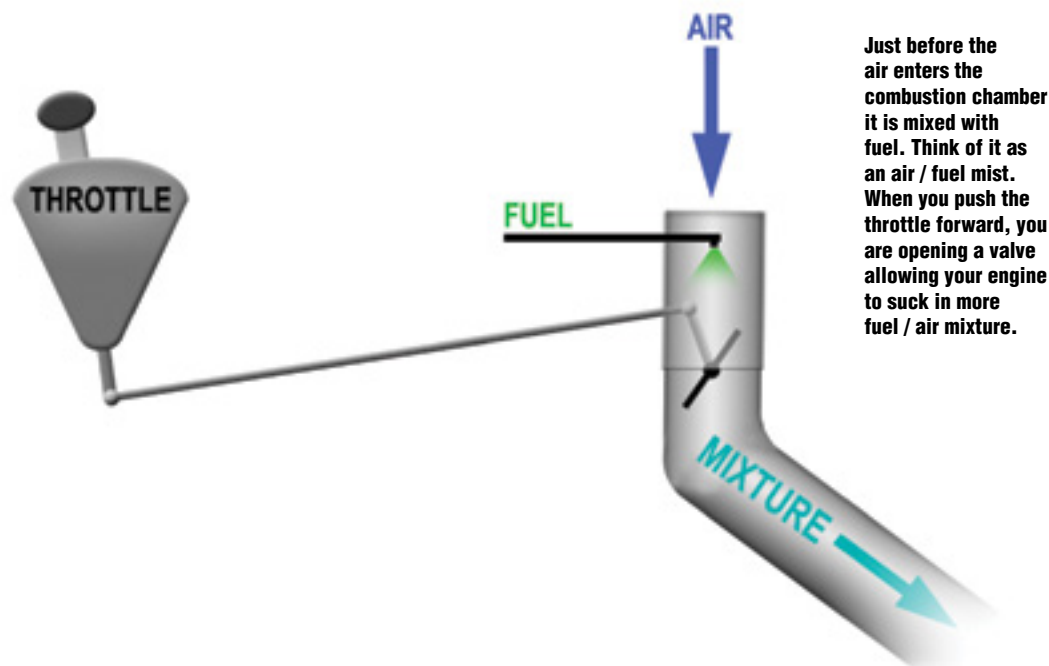
- For **HIGH POWER**, use a **RICHER** mixture.
- For **LOW POWER**, use a **LEANER** mixture.

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.



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 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.

ACCU-SIM AND THE COMBUSTION ENGINE

ENGINE TEMPERATURE

All sorts of things create heat in an engine, like friction, air temp, etc., but nothing produces heat like **COMBUSTION**.

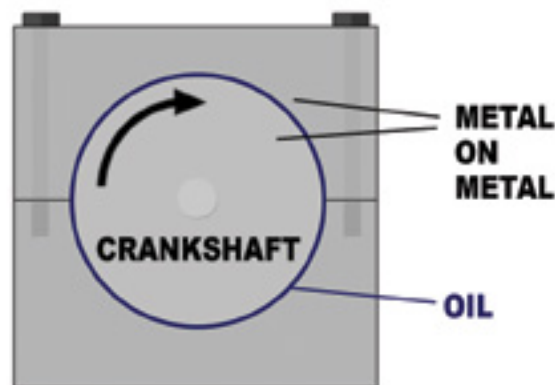
The hotter the metal, the weaker its strength.

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)

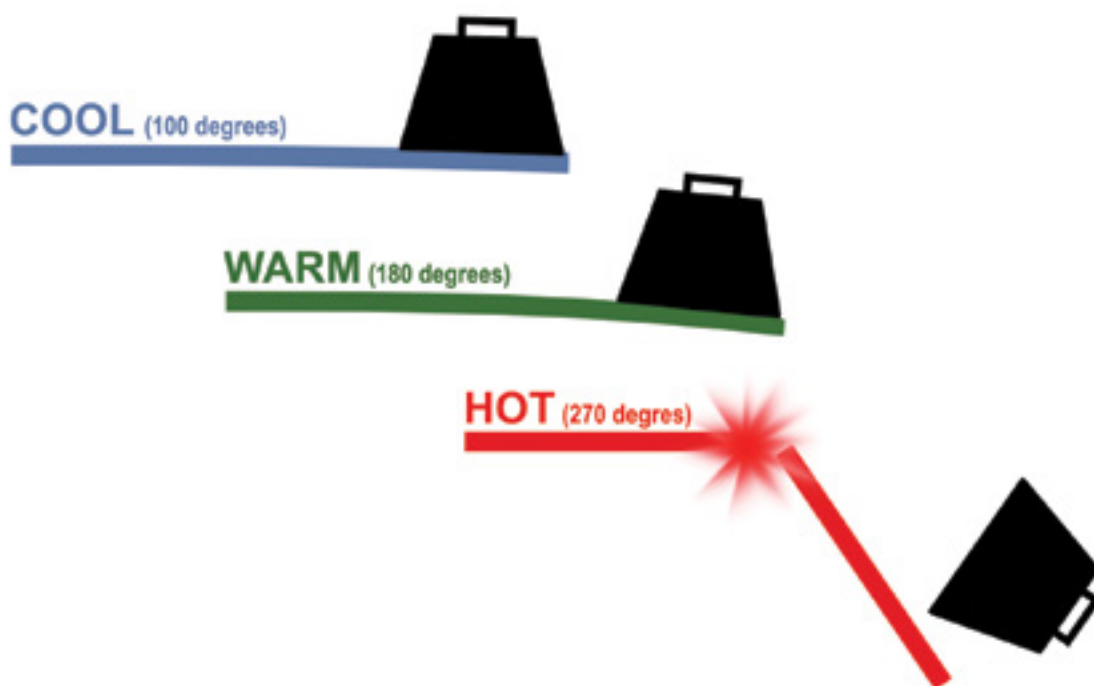
An internal combustion engine has precision machined metal parts that are designed to run against other metal surfaces. There needs to be a layer of oil between those surfaces at all times. If you were to run an engine and pull the oil plug and let all the oil drain out, after just minutes, the engine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

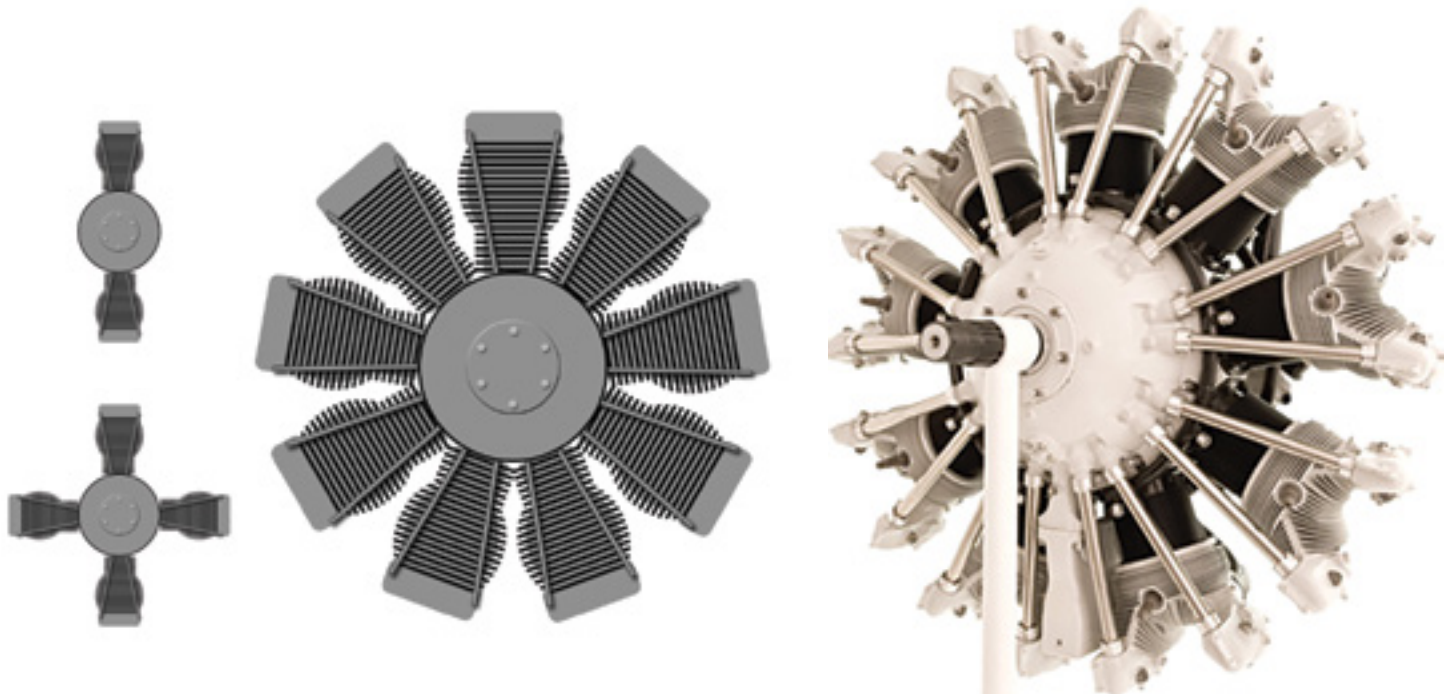
There is a minimum amount of oil pressure required for every engine to run safely. If the oil pressure falls below this minimum, then the engine parts are in danger of making contact with each other and incurring damage. A trained pilot quickly learns to look at his oil pressure gauge as soon as the 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.**



PROPELLERS



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.

It is interesting to note when discussing Bernoulli and Newton and how they relate to lift, that both theories on how lift is created were presented by each man not knowing their theory would eventually become an explanation for how lift is created.

They both were dealing with other issues of their day.

THE BERNOULLI THEORY

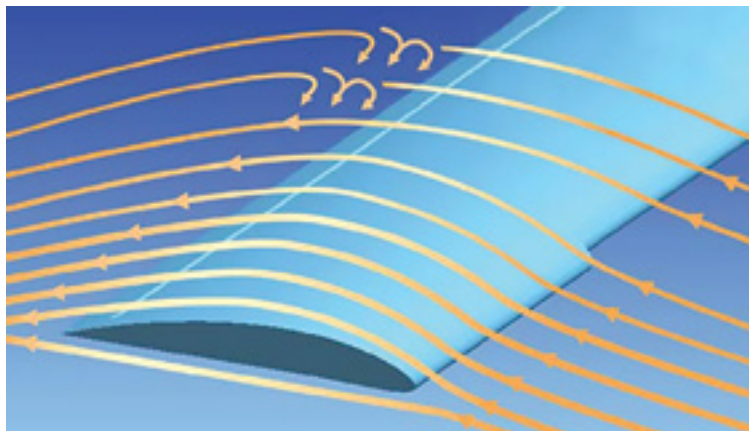
This has been the traditional theory of why an airfoil creates lift: Look at the image above which shows you how the shape of an airfoil splits the oncoming air. The air above is forced to travel further than the air at the bottom, essentially stretching the air and creating a lower pressure, or vacuum. 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 BENDING the air down with great force at its trailing edge, and thus, 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. An airfoil's lift is dependent

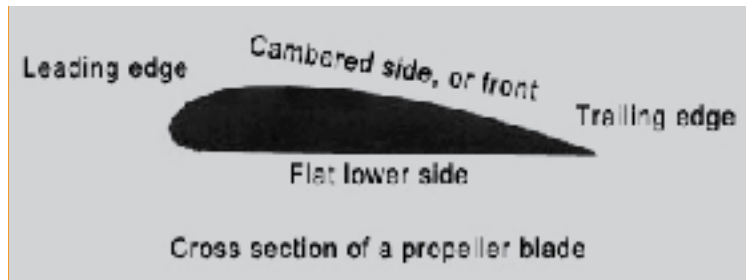


upon its shape, the speed at which it is traveling through the air, and its angle to the oncoming air (angle of attack)."

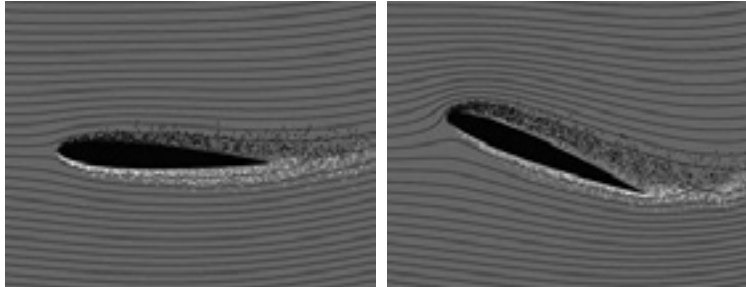
It is important that you note that we have deliberately not entered into the details and complete aerodynamics involved with either of the above explanations for lift as they go beyond the scope of this manual.

Unfortunately over time, the Bernoulli theory specifically has been misrepresented in many textbooks causing some confusion in the pilot and flight training community. Misrepresentations of Bernoulli such as the "equal transit theory" and other incorrect variations on Bernoulli have caused this confusion. Rather than get into a highly technical review of all this we at A2A simply advise those interested in the correct explanation of Bernoulli to research that area with competent authority.

PROPELLERS



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



LEFT: Level Flight. A wing creating moderate lift. Air vortices (lines) stay close to the wing.
RIGHT: Climb. Wing creating significant lift force. Air vortices still close to the wing.

For the purposes of this manual, A2A just wants you to be aware that both Bernoulli and Newton represent complete explanations for how lift is created.

The main thing we want to impress upon you here is that when considering lift and dealing with Bernoulli and Newton, it is important and indeed critical to understand that **BOTH** explanations are **COMPLETE EXPLANATIONS** for how lift is created. Bernoulli and Newton do **NOT** add to form a total lift force. **EACH** theory is simply a different way of **COMPLETELY** explaining the same thing.

BOTH Bernoulli and Newton are in fact in play and acting simultaneously on an airfoil each responsible completely and independently for the lift being created on that airfoil.

Hopefully we have sparked your interest in the direction of proper research.

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."

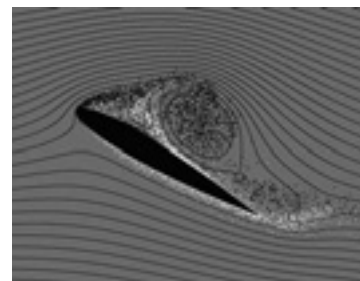
Typically, stalls in aircraft occur when an airplane loses too much airspeed to create a sufficient amount of lift. A typical stall exercise would be to put your aircraft into a climb, cut the throttle, and try and maintain the climb as long as possible. You will have to gradually pull back harder on 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.



Stall. A wing that is stalled will be unable to create significant lift.

AOA (Angle of attack)



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 its 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 on the next page, how the airfoil creates more lift as the angle of attack increases. Ideally, your wing (or propeller) will spend most of its 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 "Hershey bar wing" because it is uniform from the root to the tip, just like an Hershey chocolate bar. Later, Piper introduced the tapered wing, which stalled more gradually, across the wing. The Hershey 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

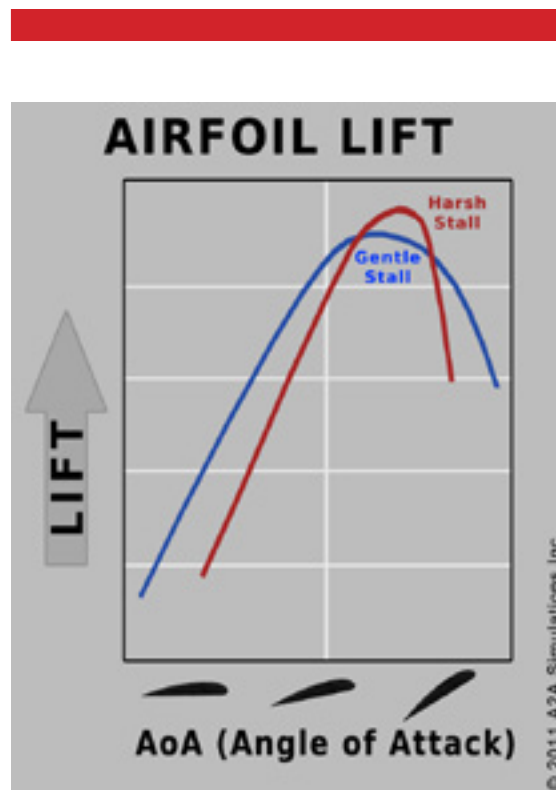
With brakes on and idling, the angle at which the prop attacks the still air, especially closer to the propeller hub, is almost always too great for the prop to be creating much lift. The prop is mostly behaving like a brake as it slams its side into the air. In reality, the prop is creating very little 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 take-off. 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

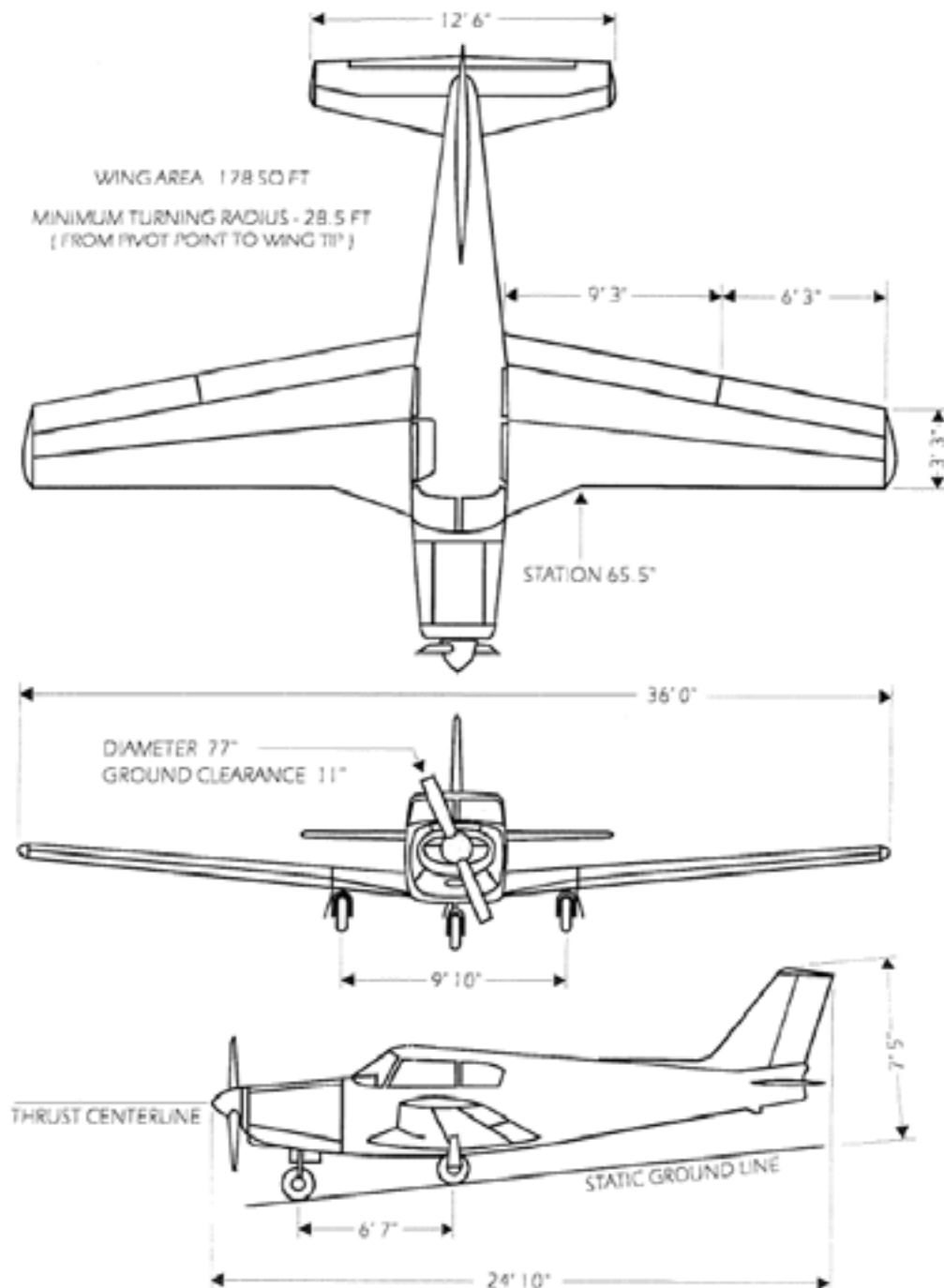
phases of flight, that we will just let you experience for the first time yourself.

PROP OVERSPEED

A fixed pitch prop spends almost all of its life out of its peak thrust angle. This is because, unless the aircraft is travelling at a specific speed and specific power it was designed for, it's either operating too slow or too fast. Lets say you are flying a P-40 and have the propeller in **MANUAL** mode, and you are cruising at a high RPM. Now you pitch down, what is going to happen? The faster air will push your prop faster, and possibly beyond its 3,000 RPM recommended limit. If you pitch up your RPM will drop, losing engine power and propeller efficiency. You really don't have a whole lot of room here to play with, but you can push it (as many WWII pilots had to).



GENERAL



ENGINES

Number of Engines 1
Engine Manufacturer Lycoming
Engine Model Number O-540-A
Rated Horsepower 250
Rated Speed (rpm) 2575
Bore (inches) 5.125
Stroke (inches) 4.375
Displacement (cubic inches) 541.5
Compression Ratio 8.5:1
Engine Type 6 Cylinder, Horizontally Opposed, Direct Drive, Air Cooled

PROPELLERS

Number of Propellers 1
Propeller Manufacturer McCaulley
Model B3D32C412-C
Number of Blades 3
Propeller Diameter (inches) 77
Propeller Type Constant speed
Number of Propellers 1
Propeller Manufacturer MT Propeller
Model MTV-9-B/188-50
Number of Blades 3
Propeller Diameter (inches) 74
Propeller Type Constant speed

FUEL

Main Fuel Capacity (U.S. gal.) 60
Usable Fuel 56
Tip Tank Capacity (U.S. gal.) 30
Usable Fuel 30
Usable Fuel Total 86
Fuel Grade, Aviation
Minimum Octane 91/96
Specified Octane 100LL

OIL

Oil Capacity (U.S. Quarts) 12
Oil Specification 15W-50 OR 20W-50
Oil Viscosity per Average Ambient Temp. for Starting

MAXIMUM WEIGHTS

Maximum Takeoff Weight (lbs) (with tip tanks) 3000
Maximum Weights in Baggage Compartment 200

STANDARD AIRPLANE WEIGHTS

Standard Empty Weight (lbs): 1690
Weight of a standard airplane including unusable fuel, full operating fluids and full oil
Maximum Useful Load (lbs): 1310
The difference between the Maximum Takeoff Weight and the Standard Empty Weight

SPECIFIC LOADINGS

Wing Loading (lbs per sq ft) 15.7
Power Loading (lbs per hp) 12

LIMITATIONS



THIS SECTION PROVIDES THE “FAA APPROVED” OPERATING LIMITATIONS, instrument markings, color coding and basic placards necessary for the operation of the airplane and its systems.

This airplane must be operated as a normal of utility category airplane in compliance with the operating limitations stated in the form of placards and markings and those given in this section and this complete handbook.

AIRSPEED LIMITATIONS

Never Exceed Speed (VNE) 203* IAS (mph)

Do not exceed this speed in any operation.
(* 229mph with stabilator tips installed)

Maximum Structural Cruising Speed (VNO) 180 IAS (mph)

Do not exceed this speed except in smooth air and then only with caution

Design Maneuvering Speed (VA)

Do not make full or abrupt control movements above this speed

At 2800 LBS. 144 IAS (mph)

At 1900 LBS. 120 IAS (mph)

Caution: Maneuvering speed decreases at lighter weight as the effects of aerodynamic forces become more pronounced. Linear interpolation may be used for intermediate gross weights. Maneuvering speed should not be exceeded while operating in rough air.

Maximum Flaps Extended Speed (VFE) 125 IAS (mph)

Landing Gear Operation Speed (VLO) 125 IAS (mph)

Maximum Landing Gear Extended Speed (VLE) 150 IAS (mph)

AIRSPEED INDICATOR MARKINGS

Red Radial Line (Never Exceed) 203 IAS (mph) *

(* 229mph with stabilator tips installed)

Yellow Arc: 180 to 227 IAS (mph)
(Caution Range – Smooth Air Only)

Green Arc: 71 to 180 IAS (mph)
(Normal Operating Range)

White Arc: 64 to 125 IAS (mph)
(Flap Down)

POWER PLANT LIMITATIONS

Number of Engines 1

Engine Manufacturer Lycoming

Engine Model No. O-540-A

ENGINE OPERATING LIMITS

Maximum Horsepower 250

Maximum Rotation Speed (RPM) 2575

Maximum Oil Temperature 245 deg F

OIL PRESSURE

Minimum (red line) 25 PSI

Maximum (red line) 100 PSI

FUEL PRESSURE

Minimum (red line) .5 PSI

Maximum (red line) 5 PSI

Fuel Grade (AVGAS ONLY) (minimum octane) 90/96 (blue)

CHT LIMITS AND VACUUM LIMITS

Max CHT 500

Vacuum Limits 4.8 - 5.1 inHg.

TYPES OF OPERATION

The airplane is approved for the following operations when equipped in accordance with FAR 91 or FAR 135:

Day V.F.R.

Night V.F.R.

Non Icing

Day I.F.R.

Night I.F.R.

NORMAL PROCEDURES





THIS SECTION CLEARLY DESCRIBES the recommended procedures for the conduct of normal operations for the Comanche 250. All of the required (FAA regulations) procedures and those necessary for the safe operation of the airplane as determined by the operating and design features of the airplane are presented.

These procedures are provided to present a source of reference and review and to supply information on procedures which are not the same for all aircraft. Pilots should familiarize themselves with the procedures given in this section in order to become proficient in the normal operations of the airplane. The first portion of this section consists of a short form check list which supplies an action sequence for normal operations with little emphasis on the operation of the systems.

The remainder of the section is devoted to amplified normal procedures which provide detailed information and explanations of the procedures and how to perform them. This portion of the section is not intended for use as an in-flight reference due to the lengthy explanations. The short form check list should be used for this purpose.

NORMAL PROCEDURES

AIRSPEEDS FOR NORMAL OPERATION

The following airspeeds are those which are significant to the safe operation of the airplane. These figures are for standard airplanes flown at gross weight under standard conditions at sea level.

Performance for a specific airplane may vary from published figures depending upon the equipment installed, the condition of the engine, airplane and equipment, atmospheric conditions and piloting technique.

Vx	Best Angle of Climb Speed	84 mph
Vy	Best Rate of Climb Speed	105 mph
Vbg	Best Glide Speed: Endurance	90 mph
	Best Glide Speed: Range	105 mph
Vs	Stall Speed, normal configuration	71 mph
Vso	Stall Speed, landing configuration	64 mph
Vfo	Maximum Flap Extension Speed	125 mph
Va	Maneuvering Speed (at gross weight)	144 mph
Vno	Maximum Structural Cruising Speed	180 mph
Vne	Never Exceed Speed	203 mph
	(with stabilator tips installed)	229 mph
	Normal Climb Out	120 mph
	Short Field T/O, Flaps 18°, rotate	70 mph
	Final Approach, Flaps Up	95 mph
	Final Landing Approach, Flaps 40°	90 mph
	Maximum Demonstrated Crosswind Velocity	17 kts

PREFLIGHT

When the aircraft is stopped with the engine off, press SHIFT-8 to bring up the interactive preflight inspection.



STARTING

After completion of preflight inspection:

1. Fuel selector to the proper tank.
2. Mixture control full in, "RICH" position.
3. Carburetor heat control full in, "COLD" position.
4. Throttle open 1/4 inch.
5. Propeller control full in "INCREASE RPM" .
6. Turn master switch to "ON" position.
7. Turn the auxiliary fuel pump switch "ON", listen for pump to operate and note fuel pressure indication.
8. Prime. When engine is cold (under 40° F) prime three to five strokes, if engine is warm do not prime.
9. Check all radios for being "OFF".
10. Check the propeller area for being "CLEAR" .
 - a. Engage the starter and allow the engine to turn approximately one full revolution then
 - b. Turn the ignition switch to the "Both" magneto position
 - c. (Limit starter operation to 30 seconds)

NOTE: If the above procedure does not start the engine re-prime and repeat the process. If the engine is over-primed, open the throttle and turn the engine over with the starter. If the engine still fails to operate, check for malfunctioning of ignition or fuel system.

When the engine is firing evenly, adjust the throttle to 800 RPM. Check the oil pressure gauge for a pressure indication. If oil pressure is not indicated within thirty seconds, stop the engine and determine the trouble. If the engine fails to start at the first attempt, another attempt should be made without priming. If this fails, it is possible that the engine is over primed. Turn the magneto switch off, open the throttle slowly, and rotate the engine approximately ten revolutions with the starter. Re-prime the engine with one half the amount used in the initial attempt, turn the magneto switch to "Both", and repeat the starting procedure.

WARM-UP AND GROUND CHECK

As soon as the engine starts, the oil pressure should be checked. If no pressure is indicated within thirty seconds, stop the engine and determine the trouble. In cold weather it will take a few seconds longer to get an oil pressure indication.

Warm-up the engine at 800 to 1200 RPM for not more than two minutes in warm weather, four minutes in cold weather. If electrical power is needed from the generator, the engine can be warmed up at 1200 RPM at which point the generator cuts in. The magnetos should be checked at 2000 RPM, the drop not to exceed 125 RPM with manifold pressure of 15" MAP. The engine is warm enough for take-off when the throttle can be opened without the engine faltering.



Carburetor heat should be checked during the warm-up to make sure the heat control operation is satisfactory and to clear out the carburetor if any ice has formed. It should also be checked in flight occasionally when outside air temperatures are between 20° F and 70° F to see if icing is occurring in the carburetor. In most cases when an engine loses manifold pressure without apparent cause, the use of carburetor heat will correct the condition.

When carburetor heat is applied, cold air entering the induction system is taken from a rear baffle to an exhaust pipe shroud, then to the carburetor; it is not filtered. For this reason carburetor heat should not be used on the ground in dusty conditions except momentarily during the run-up. Dust taken into the intake system can damage the engine severely, and caution must always be exercised during ground operation to prevent dust from entering the engine.

The propeller control should be moved through its normal range during the warm-up to check for proper operation, then left in the full high RPM position. During cold weather operation the propeller should be cycled a minimum of three times to insure that warm engine oil has circulated throughout the system.

During the propeller check, as during other ground operations, care must be taken not to run-up the engine with the propeller over loose stones, cinders or other objects which can be picked up by the propeller, and which frequently cause extensive damage to the propeller blades.

TAKE-OFF

Just before take-off the following items should be checked:

1. Controls free
2. Flaps set
3. Tab set
4. Propeller set
5. Mixture rich
6. Carburetor heat off
7. Fuel on proper tank
8. Electric fuel pump on
9. Engine gauges normal
10. Door latched
11. Safety belts fastened

In a smooth, steady motion of the throttle apply full power allowing the aircraft to accelerate in the three point attitude until the control surfaces become effective. Then apply slight back pressure on the control column to lift the nose wheel. Under normal take-off conditions the Comanche will leave the ground at about 65 M. P.H. Trying to pull the aircraft off before the proper speed is obtained will only prolong the take-off run. After the take-off has proceeded to the point at which a landing could no longer be made with the wheels down in the event of power failure, the gear should be retracted. As soon as the gear is up and sufficient altitude has been gained, reduce power to climb setting.

NORMAL PROCEDURES

For a minimum take-off run in the Comanche 250, the flaps should be lowered to the recommended 18° (¾) position. With the flaps in this position the take-off run will be reduced approximately 20 per cent.

Normally flaps are not used during crosswind take-offs. It is desirable to hold the nose wheel on the runway until a higher than normal take-off speed is obtained, then apply a definite but not abrupt back pressure to the control column to lift the aircraft from the runway. Once airborne, set up the required crab angle, retract the gear, and continue the climbout.

During cold weather operation, when taking off from slush or water covered runways, allow the gear to remain down longer than usual so that any slush remaining on the gears will freeze and will be broken away when the wheels are retracted.

CLIMB

Max recommended climb power is 2,400 RPM at 24" manifold pressure. The best rate of climb is obtained at 105 MPH. This speed should be decreased about 1 MPH. per thousand feet of altitude so that at 10,000 feet the best airspeed for maximum rate of climb is 95 MPH. A good rate of climb is obtained at lower altitudes is 110 to 120 MPH, while forward speed is increased. Reducing the climbing airspeed below 95 MPH at low altitudes has the added disadvantage of cutting down forward visibility and reducing airflow for engine cooling. Extended climbs at speeds below that figure are not recommended.

STALLS

The gross weight stalling speed with flaps and gear down is 61 MPH. The stall speed will increase about 7 MPH in the clean configuration. All controls are effective at speeds down to the stalling speed. Stalls are gentle and the airplane is easily controlled if back pressure is released from the yoke.



CRUISING

The cruising speed of the Comanche models is determined by many factors including power setting, altitude, temperature, load and equipment installed on the airplane. The 250 Comanche has a maximum recommended cruising speed of 182 MPH. At 75% power at 7000 feet, 2400 RPM and 22.6" MAP. Fuel consumption at this speed approximates 14 gallons per hour when leaning to Best Economy Cruise (Peak EGT). To keep engine wear, fuel consumption, and noise at reasonable levels, cruising RPM's from 2000 to 2400 are recommended with appropriate Manifold Pressures to obtain power settings of 65% to 75% power at low and intermediate altitudes.

For maximum efficiency (highest cruising range), the best power settings during cruising flight are with minimum RPM and the necessary Manifold Pressures to obtain a given percent of power, consistent with the recommended limitations. Engine smoothness and noise level should be major factors in determining the best RPM. Use of the mixture control in cruising flight reduces fuel consumption significantly, especially at higher altitudes. The mixture should always be leaned during cruising operation over 5000 feet altitude, and normally also at lower altitudes at the pilot's discretion.

The continuous use of carburetor heat during cruising flight reduces power and performance. Unless icing



conditions in the carburetor are severe, do not cruise with the heat on. Apply heat slowly and only for a few seconds at intervals determined by icing severity.

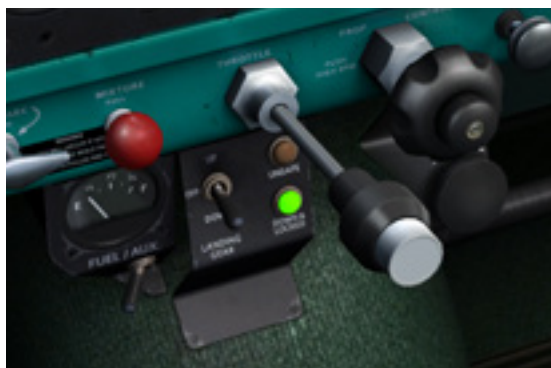
In order to keep the airplane in best lateral trim during cruising, the fuel should be used alternately from each tank. If tip tanks are installed, it is suggested to use the fuel in the tip tanks first.

CAUTION: In keeping with general practice for all aircraft, it is recommended that when flying in turbulent air or active weather such as storm conditions, that the aircraft not exceed its turbulent air penetration speed, also known as maneuvering speed which is 129 mph.

APPROACH AND LANDING

Before Landing Check List:

1. Mixture "RICH".
2. Propeller set.
3. Carburetor heat "OFF" (unless icing conditions exist).
4. Electric fuel pump "ON" .
5. Fuel selector on proper tank.
6. Landing gear "DOWN", under 150 MPH (Check green light "ON", warning horn "OFF", gear emergency handle in "FORWARD" position.)
7. Flaps as desired (under 125 MPH)
8. Safety belts fastened



During the approach, the landing gear can be lowered at 150 MPH or lower, preferably on the downwind leg. The flaps can be lowered at 125 MPH or below, if desired. For final approach, trim the aircraft to approximately 90 MPH with full flaps, or approximately 95 MPH with no flaps. The propeller should be set for high RPM to facilitate a go-around if required. Carburetor heat generally is not applied during landing unless icing conditions are suspected. If a landing is aborted move the carburetor heat to the off position immediately if full power is desired .

The amount of flap used during landings and the speed of the aircraft at contact should be varied according to the wind, the landing surface, and other factors. It is always best to contact the ground at the minimum practicable speed consistent with landing conditions.

Normally, the best technique for short and slow landings is to use full flap and a small amount of power, holding the nose up as long as possible before and after ground contact. In high wind conditions, particularly in strong crosswinds, it may be desirable to approach the ground at higher than normal speeds with partial or no flap.

Maximum braking effect during short field landings can be obtained by holding full back on the control wheel with flaps up while applying brakes. This forces the tail down and puts more load on the main wheels, resulting in better traction.

A handy way to remember critical landing in a high performance retractable plane is to say: "GUMPS"

GAS —	Fuel selectors on desired tank with fuel pump ON
UNDERCARRIAGE —	Down and locked
MIXTURE —	RICH (In)
PROP —	HIGH (In)
SEATBELTS —	ON

WEIGHT AND BALANCE -

It is the responsibility of the owner and pilot to determine that the airplane remains within the allowable weight vs center of gravity envelope while in flight. For weight and balance data see the latest Weight and Balance Form supplied with each airplane.

PERFORMANCE

THE PERFORMANCE INFORMATION PRESENTED in this section is based on measured Flight Test Data corrected to ICAO standard day conditions and analytically expanded for the various parameters of weights, altitude, temperature, etc. The performance charts are unfactored and do not make any allowance for varying degree of pilot proficiency or mechanical deterioration of the aircraft. The performance however can be duplicated by following the stated procedures in a properly maintained airplane.

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



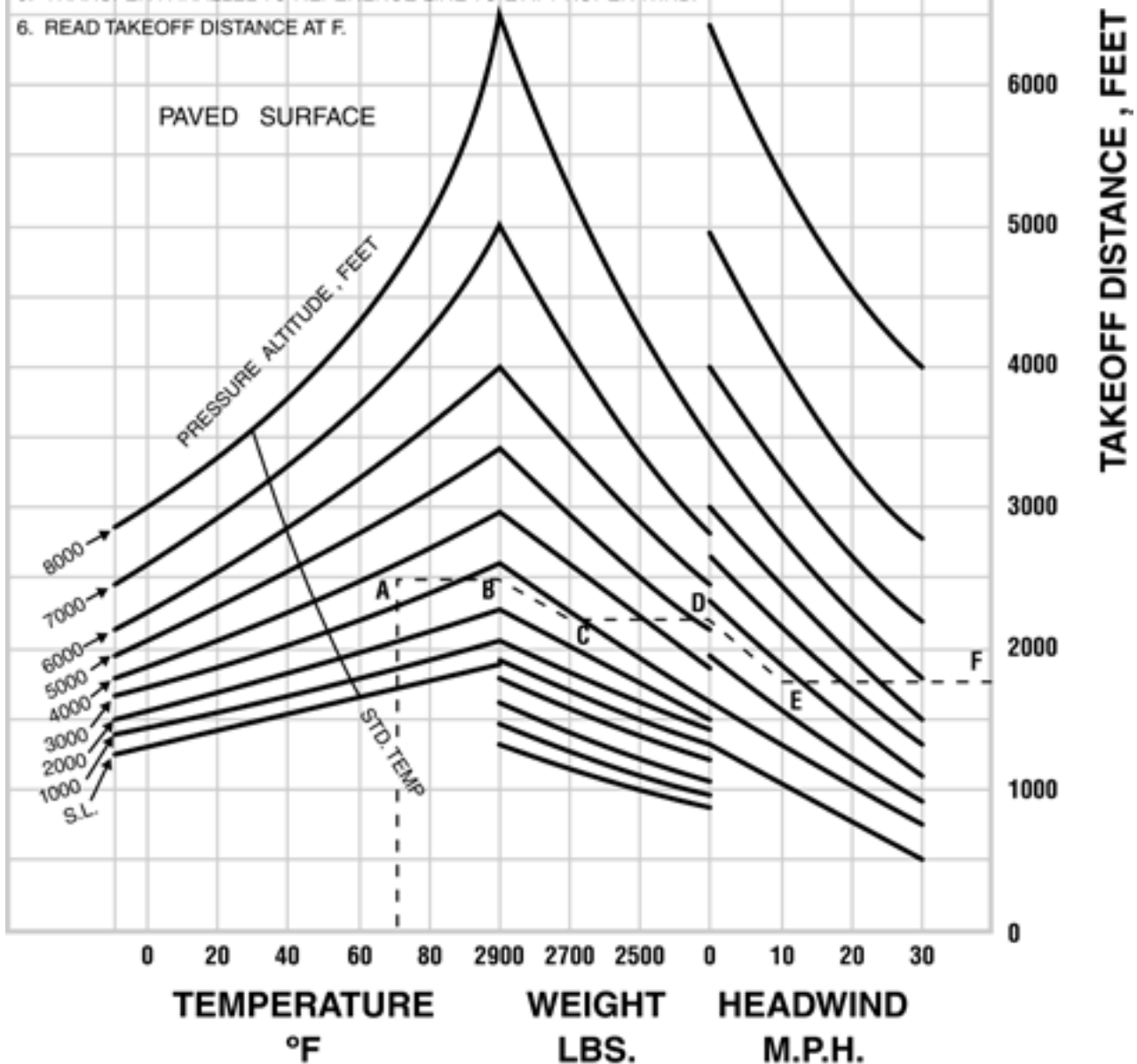
TAKEOFF DISTANCE OVER 50 FOOT OBSTACLE AT VARIOUS ALTITUDES , TEMPERATURES , WEIGHTS AND WINDS

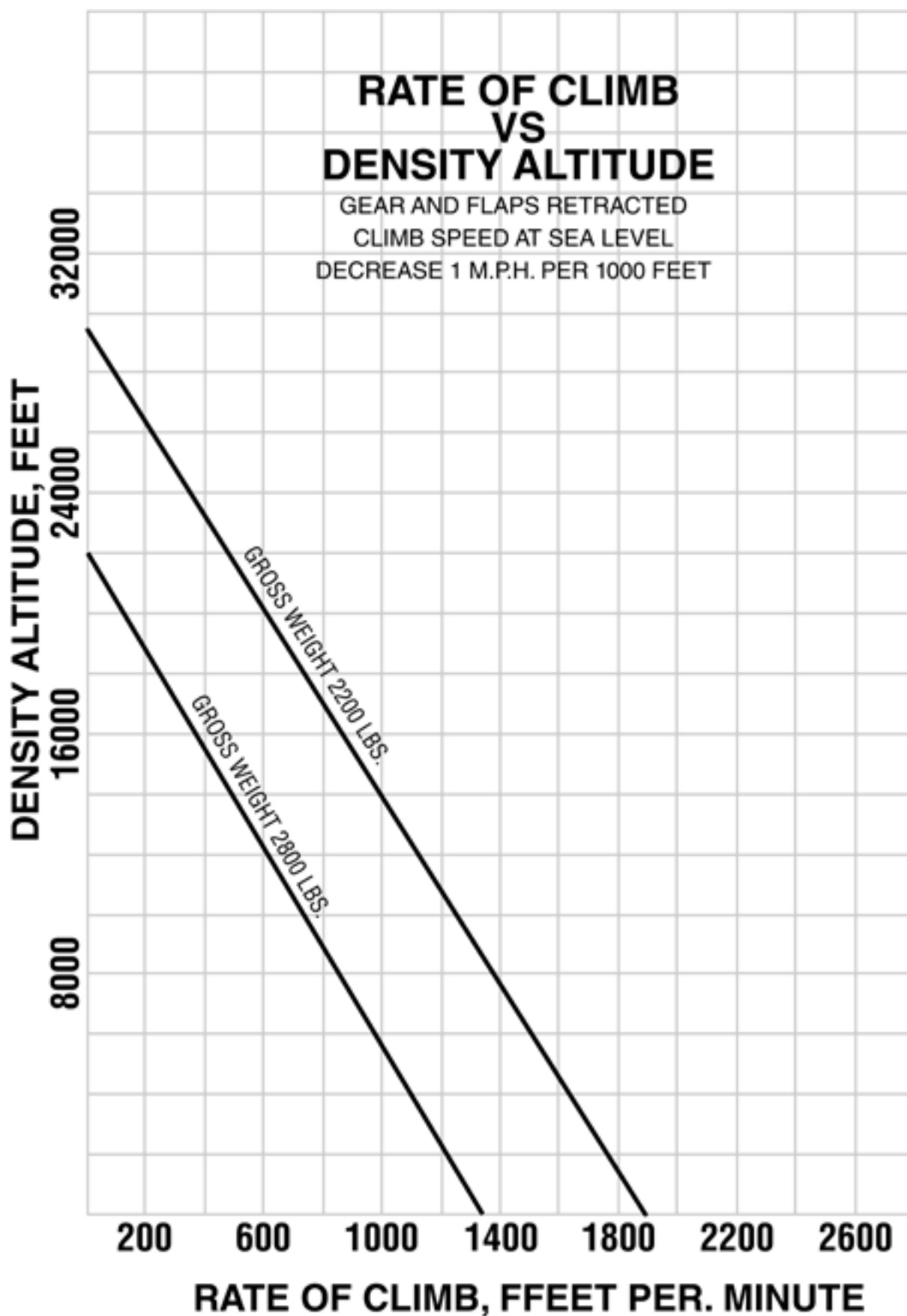
15° SLOTTED FLAPS

TAKEOFF AT 1.30 X STALL SPEED

TO OBTAIN TAKEOFF DISTANCE -

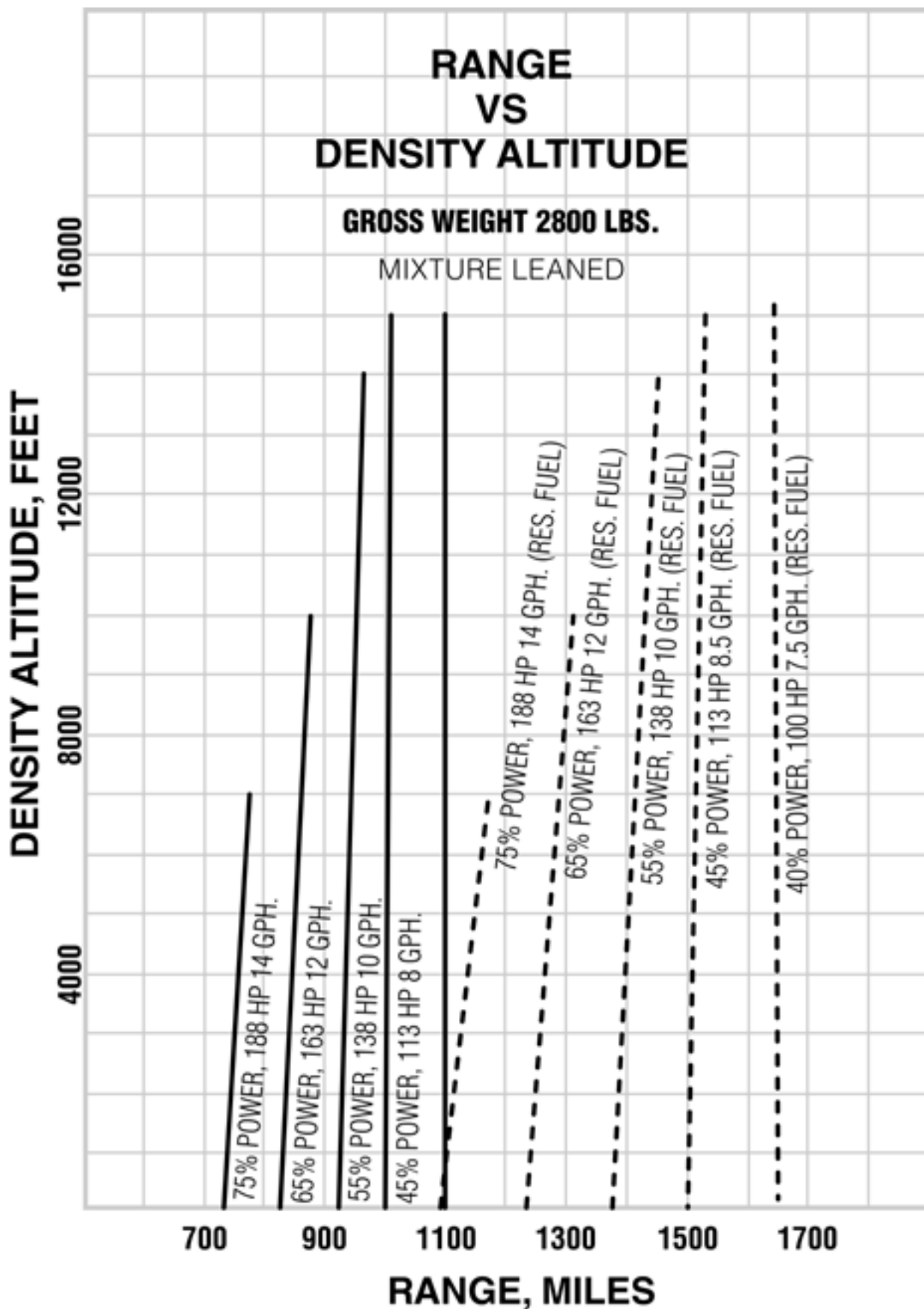
1. PLOT TEMPERATURE AND PRESSURE ALTITUDE AT A.
2. TRANSFER TO B ON 2900 GROSS WEIGHT LINE.
3. TRANSFER PARALLEL TO REFERENCE LINE TO C AT PROPER GROSS WEIGHT.
4. TRANSFER TO D ON 0-WIND LINE.
5. TRANSFER PARALLEL TO REFERENCE LINE TO E AT PROPER WIND.
6. READ TAKEOFF DISTANCE AT F.



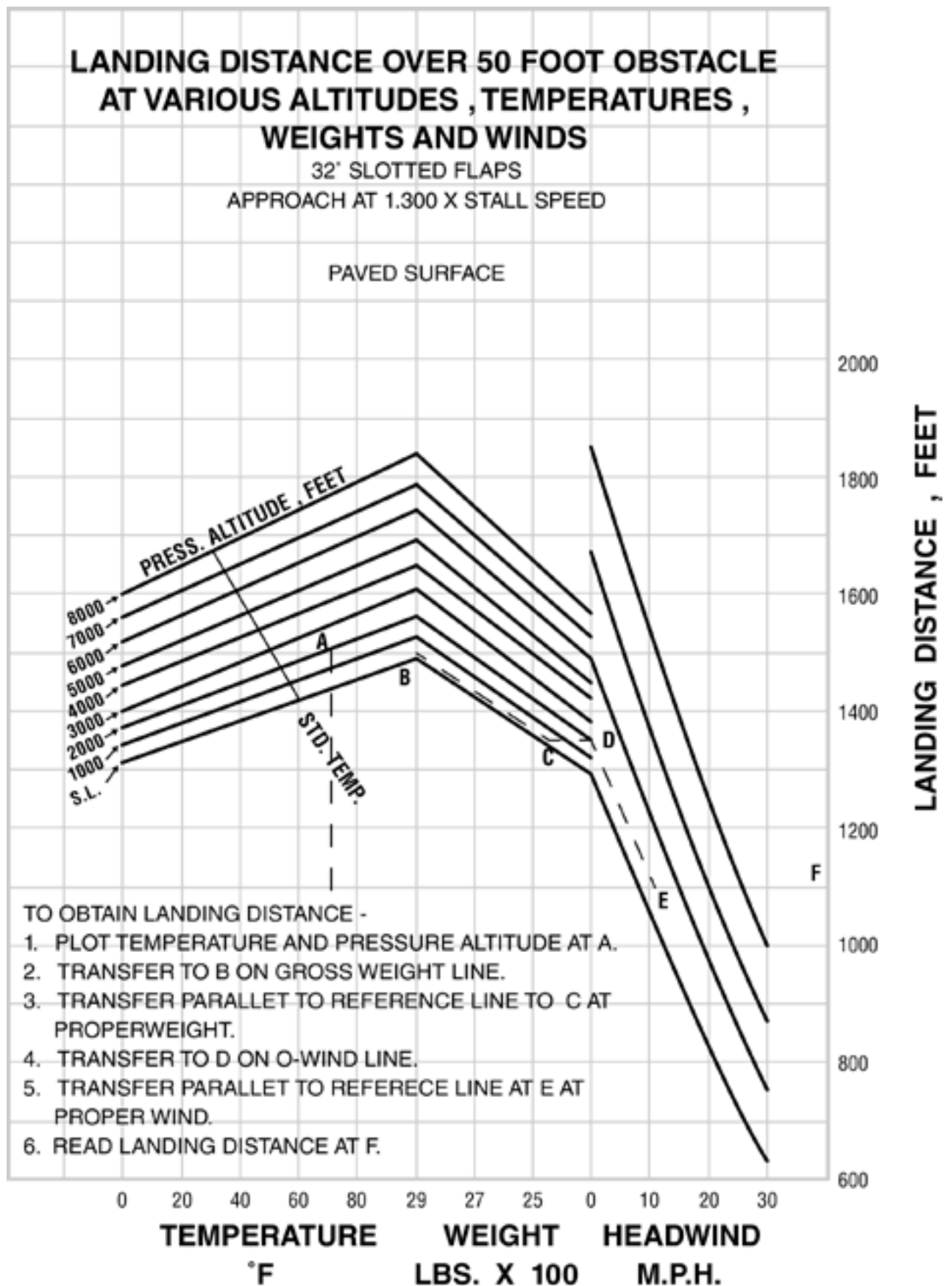








PERFORMANCE



POWER SETTING TABLE

LYCOMING MODEL O-540-A, 250 HP NORMALLY ASPIRATED ENGINE

PRESSURE ALTITUDE	STD AIR TEMP F. C.	138 HP - 55% RATED			163 HP - 65% RATED			188 HP - 75% RATED		
		1. APPROX 10.3 GPH			APPROX 12.3 GPH			APPROX 14.0 GPH		
		2. APPROX 12.0 GPH			APPROX 14.0 GPH			APPROX 16.0 GPH		
		RPM AND MAN PRESS			RPM AND MAN PRESS			RPM AND MAN PRESS		
		2100	2200	2300	2400	2100	2200	2300	2400	2200 2300 2400
SEA LEV	59 15	21.6	20.8	20.2	19.6	24.2	23.3	22.6	22.0	25.8 25.1 24.3
1,000	55 13	21.4	20.6	20.0	19.3	23.9	23.0	22.4	21.8	25.5 24.8 24.1
2,000	52 11	21.1	20.4	19.7	19.1	23.7	22.8	22.2	21.5	25.3 24.6 23.8
3,000	48 09	20.9	20.1	19.5	18.9	23.4	22.5	21.9	21.3	25.0 24.3 23.6
4,000	45 07	20.6	19.9	19.3	18.7	23.1	22.3	21.7	21.0	24.8 24.1 23.3
5,000	41 05	20.4	19.7	19.1	18.5	22.9	22.0	21.4	20.8	23.8 23.0 22.8
6,000	38 03	20.1	19.5	18.9	18.3	22.6	21.8	21.2	20.6	
7,000	34 01	19.9	19.2	18.6	18.0	22.3	21.5	21.0	20.4	
8,000	31 -01	19.6	19.0	18.4	17.8		21.3	20.7	20.1	
9,000	27 -03	19.4	18.8	18.2	17.6			20.5	19.9	
10,000	23 -05	19.1	18.6	18.0	17.4				19.6	
11,000	19 -07	18.9	18.3	17.8	17.2					
12,000	16 -09	18.6	18.1	17.5	17.0					
13,000	12 -11		17.9	17.3	16.8					
14,000	09 -13			17.1	16.5					
15,000	05 -15				16.3					

1.) BEST ECONOMY CRUISE - PEAK EGT (FOR LEANEST CYLINDER)

2.) BEST POWER CRUISE - 100 DEGREES FAHRENHEIT RICH OF PEAK EGT (FOR LEANEST CYLINDER)

** NOTE **

TO MAINTAIN CONSTANT POWER, CORRECT MANIFOLD PRESSURE APPROXIMATELY 0.17 INCH Hg. FOR EACH 10 DEGREE FAHRENHEIT VARIATION IN CARBURETOR AIR TEMPERATURE FROM STANDARD ALTITUDE TEMPERATURE. ADD MANIFOLD PRESSURE FOR TEMPERATURES ABOVE STANDARD; SUBTRACT FOR TEMPERATURES BELOW STANDARD.

WEIGHT AND BALANCE



IN ORDER TO ACHIEVE THE PERFORMANCE AND FLYING characteristics which are designed into the airplane, it must be flown with the weight and center of gravity (C.G.) positioned within the approved operating range (envelope). Although the airplane offers flexibility of loading, it cannot be flown with the maximum number of adult passengers, full fuel tanks, and maximum baggage. With the flexibility comes responsibility. The pilot must ensure that the airplane is loaded within the loading envelope before he makes a takeoff.



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

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

WEIGHT AND BALANCE LOADING FORM

For use with Tip Tanks and MT propeller.
(example using two 170 lbs passengers, full fuel, and 50lbs of baggage)

	Weight (lbs.)	Datum (in.)	Moment (in-lbs.)
Basic Empty Weight	1709	83.9	143,385
Front Seats	340	84.8	28,832
Rear Seats*	0	118.5	0
Main Fuel (max 60gal)	360	90.0	32,400
Tip Tanks (max 30gal)	180	91.5	16,470
Baggage*	50	142	7,100
Total	2,639		222,187

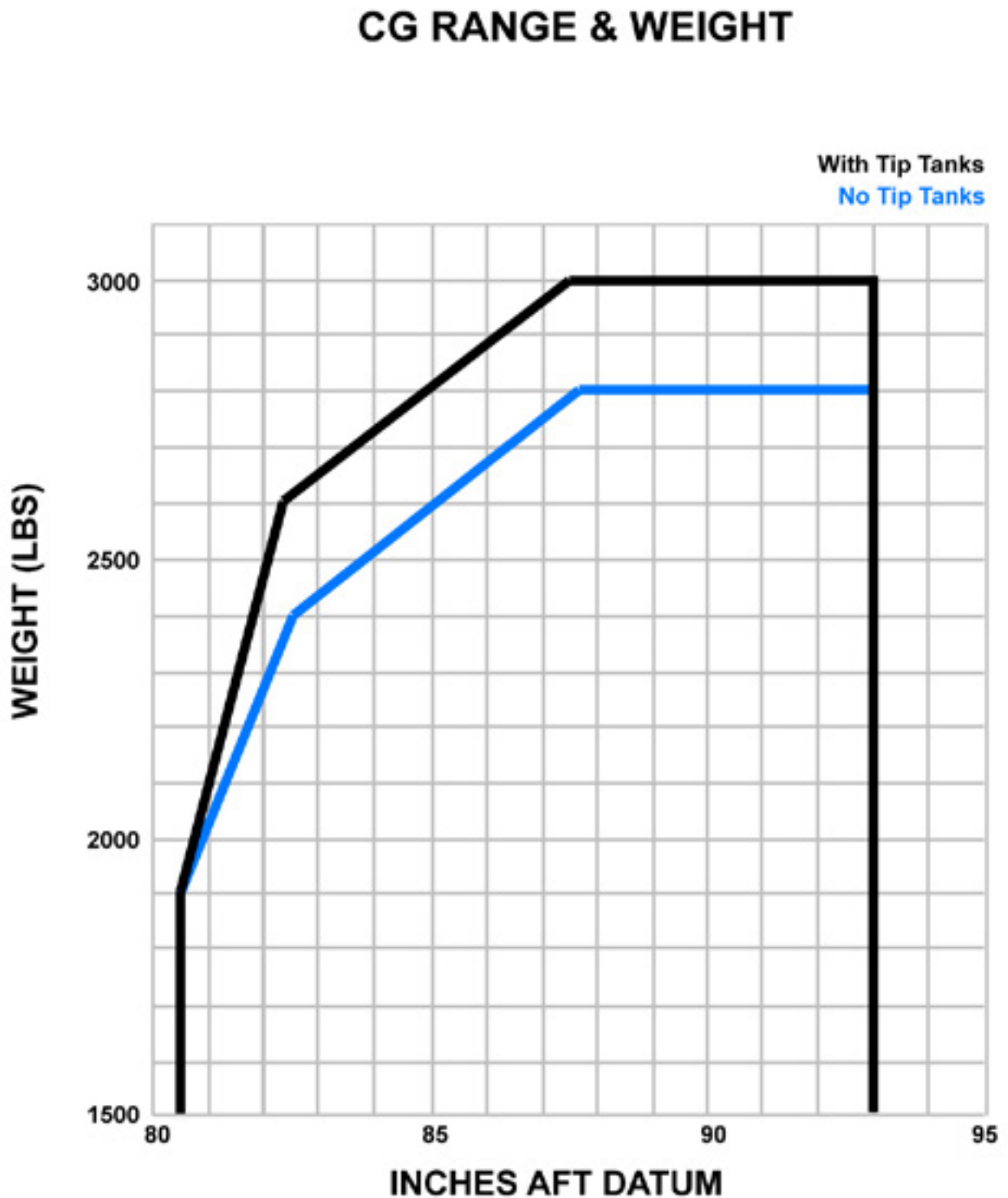
NOTE: Typically, empty weight includes unusable fuel, but in A2A's "29p" pilot's operating manual, it does not.

How to calculate the center of gravity:

Total Moment ÷ Total Weight = C.G. (center of gravity)

222,187 ÷ 2,639 = 84.19

C.G. = 84.19







THE PA-24-250 COMANCHE is a single-engine, low-wing, retractable landing gear monoplane of all metal construction. It has four place seating, two hundred pound baggage capacity, and a 250 horsepower engine.

ENGINE AND PROPELLER

The Comanche PA-24-250 is powered by a Lycoming O-540-A engine (direct drive, wet sump, horizontally opposed), developing 250 HP at 2575 RPM. The compression ratio of 8.5 to 1 and the minimum required use of 91/96 Aviation fuel.

The engine is furnished with a geared starter, 50 ampere 12 volt generator, vacuum pump drive, and carburetor air box and filter.

Exhaust gases from the engine are carried overboard through an exhaust manifold. The manifold incorporates a stainless steel muffler fitted with a heater shroud which provides heat for both the cabin interior and the carburetor heat system.

Engine cooling is accomplished without the usual cowl flaps, exhaust augmenters, or drag producing fixed cowl flanges.

There are two different models of propellers used for the A2A Accu-Sim simulator:

1. McCaulley constant speed 77" diameter 3-blade
2. MT Propeller constant speed 74" diameter 3-blade

Both propellers are controlled by a governor mounted on the engine which supplies oil to the propeller through the engine shaft. The governor in turn is controlled by the propeller control in the cockpit.



STRUCTURES

Structures are of sheet aluminum construction, and are designed to ultimate load factors well in excess of normal requirements. All components are completely zinc chromate primed, exterior surfaces are coated with acrylic lacquer.

The main spars of the wings are jointed with high strength butt fittings in the center of the fuselage, making in effect a continuous main spar. The spars are attached to the fuselage at the side of the fuselage and in the center of the structure; wings are also attached at the rear spar and at an auxiliary front spar.

The wing airfoil section is a laminar flow type, NACA-642A215, with maximum thickness about 40% aft of the landing edge. This permits the main spar, located at the point of maximum thickness, to pass through the cabin under the rear seat, providing unobstructed cabin floor space ahead of the rear seat.

LANDING GEAR

The nose gear is steerable with the rudder pedals through a 40 degree arc. During retraction of the gear the steering mechanism is disconnected automatically to reduce rudder pedal loads in flight. The nose gear is equipped with a hydraulic shimmy dampener.

Retraction of the landing gear is accomplished through the use of an electric motor and gear train located under the floorboards, actuating push-pull cables

to each of the gears. The landing gear motor is activated by a selector switch located on the instrument panel.

As an added safety feature, the warning horn is connected to the gear selector switch. The horn will then operate if the selector is moved to the "UP" position with the master switch on and the weight of the airplane is on the landing gear. As a final safety factor to prevent gear retraction on the ground, an anti-retraction switch is installed on the left main gear. This prevents the electric circuit to the landing gear motor from being completed until the gear strut is fully extended. A green light on the instrument panel below the landing gear switch is the indication that all gears are down and locked. The warning horn will also sound if the power is reduced below approximately 12" of manifold pressure and the gear has not been lowered.

The telescoping emergency gear handle should not be used as the primary indication that the gear is down and locked. An amber light above the switch indicates gears up. **THE INDICATION LIGHTS ARE AUTOMATICALLY DIMMED WHEN THE NAVIGATION LIGHTS ARE TURNED ON.**

The brakes on the Comanche are actuated by toe brake pedals mounted on the left set of rudder pedals or by a hand lever protruding from under the instrument panel. Hydraulic brake cylinders are located above the left rudder pedals and are accessible in the cockpit for servicing. Parking brake valves are incorporated in each

cylinder. Two cables extending from the parking brake “T” handle are attached to the parking brake valves. To prevent inadvertent application of the parking brake in flight, a safety lock is incorporated in the valves thus eliminating the possibility of pulling out the “T” handle until pressure is applied by use of the toe brakes or the hand lever.

CONTROL SYSTEMS

The flight controls on the Comanches are the conventional three control type operated by a control column and rudder pedals. The movable stabilator, with an anti-servo tab which also acts as a longitudinal trim tab provides extra stability and controllability with less size drag and weight.

Provision for directional and longitudinal trim is provided by an adjustable trim mechanism for the rudder and stabilator. Dual flight controls are installed in the Comanche as standard equipment.

A hand brake is provided to operate the brakes while occupying the right seat.

The flaps on the Comanche are mechanically operated and can be positioned in the three locations of 9°, 18°, and 27°. Locks on the inboard ends of the flaps hold them in the “UP” position so the right flap can be stepped on for entry or exit. A second lock is incorporated to prevent the flap from going full down in case a step load is applied and the full up lock was not fully engaged.

COMANCHE OWNER’S NOTE: Even though technically the flaps can hold the weight of a person, most if not all Comanche owners we know don’t let people use the flaps as a step.

FUEL SYSTEM

The fuel for the Comanche is carried in two rubber-like fuel cells located in the inboard leading edge sections of the wings. Capacity of these cells, which are classified as the main fuel cells, are 30 gallons each.



60 gallons is the standard fuel capacity of which 56 gallons is usable; however, if tip tanks are installed the fuel capacity is increased to 90 gallons of which a total of 84 gallons is usable.

During normal operation the fuel is drawn to the engine from the cell by a mechanically operated fuel pump located on the engine accessory section. In the event the engine driven fuel pump fails, two electric auxiliary fuel pump are provided. The pumps are operated (via a single switch) during starting, take-offs, and landings.

The fuel strainer, equipped with a quick drain, is mounted under the right forward section of the fuselage. The strainer should be drained regularly to check for water or dirt accumulations.

The procedure for draining the right and left tanks and lines is to open the gasculator quick drain for a few seconds with the fuel tank selector on one tank. Then change the fuel selector to the opposite tank and repeat the process, allowing enough fuel to flow out to clear the line as well as the gasculator.

ELECTRICAL SYSTEM

Electrical power for the Comanche is supplied by a 12 volt, direct current system. Incorporated in the current system is a 12 volt 50 ampere generator, which furnishes electrical power during all normal operation. A 12 volt 33 ampere hour battery is used in the system to provide power for starting and as a reserve power source in case of generator failure. The battery is located behind the baggage compartment bulkhead in a sealed stainless steel battery box. Refer to the Maintenance Section for servicing of the battery.

Electrical switches and circuit breakers for the different systems are located on the lower left instrument panel. The circuit breakers automatically break the electrical circuit if an overload is applied to the system, thereby preventing damage to the component and wiring.

To reset the circuit breakers simply push in the reset button. Allow approximately two minutes for breakers to cool prior to resetting. Continual popping out of a circuit breaker indicates trouble in that circuit and must be checked prior to operation. It is possible to manually trip the breaker by pulling out on the reset button.

HEATING AND VENTILATING SYSTEM

There are four individual controls provided for regulating the heating, defrosting, and forward fresh ventilating air. The controls are located on the lower right side of the instrument panel in the console panel.

Heated air for the cabin is provided by a heater shroud attached by the exhaust muffler. Fresh air is picked up at the rear engine baffle and passed through the heater shroud into a control valve for distribution to the cabin.

Warm air for the defroster system is obtained directly from the heater shroud. The amount of air applied to the

AIRPLANE & SYSTEM DESCRIPTIONS

windshield is regulated with the control in the console. Caution should be used if it is necessary to operate the defroster on the ground as prolonged application of heat to the windshield may cause distortion.

Fresh air for the cabin interior is picked up from two air scoops attached to the lower engine cowl. The air passes through flexible hoses to control valves on the firewall where the flow is regulated to the cabin. Located at each seat are two smaller air vents that may be regulated by the individual.

Located in the aft section of the cabin is an exhaust vent to improve the circulation of air in the cabin interior.

INSTRUMENT PANEL

The instrument panel in the Comanche is designed to accommodate the customary advanced flight instruments on the left side in front of the pilot and the engine instruments on the right side. Provisions for extra instruments are made in both sections. Instruments are shock mounted and accessible for maintenance by removing a portion of the fuselage cowl over the instruments.

The artificial horizon and the directional gyro in the flight group are vacuum operated through the use of a vacuum pump installed on the engine. The turn coordinator is an electrically operated instrument and serves as a standby for the other gyros in case of vacuum system failure (partial panel).

Radios are installed in the left of the panel. Radio power supplies are mounted aft of the baggage compartment.

BAGGAGE COMPARTMENT

Maximum placarded weight of the baggage area is 200 pounds with 20 cubic feet of area available, accessible through a 20 x 20 inch door. Provision for securing cargo is provided by tie-down belts installed in the compartment. Attached to the top of the baggage compartment are provisions for stowing the tow bar. The key used in the ignition operates the lock on the baggage compartment door.

SEATS

Front seats are adjustable so as to provide comfort and facilitate ease of entry and exit from the aircraft for pilot and passengers. They are easily removed by taking out the stops at the end of the mounting tracks and sliding the seats off their tracks. The back of the rear seat is adjusted to various fore and aft positions by use of the latches at the outboard upper corners. The entire rear seat is removed quickly by disengaging the aft seat bottom tube from its attachment clamps, detaching the latches behind the top of the seat back, removing the center safety belt bolt, then lifting both the seat and the back as one unit from the cockpit.

CENTER STACK AVIONICS SUITE

We have spent much time developing extra modes and functions that you won't find in any Prepar3D airplane, like independent DME receiver, pilot- programmable COMM channels and NAV OBS mode. For example, you should pay attention to the autopilot. Even though it may look familiar, you need to learn how to operate it properly or you may find you plane going in completely wrong direction.

The avionics suite in your Accu-Sim Piper Comanche 250 is so complete, the best source for your information is straight from the manufacturer. Below are links to the latest manuals online:

<http://a2asimulations.com/downloads/manuals/STEC%2020-30-30alt.pdf>

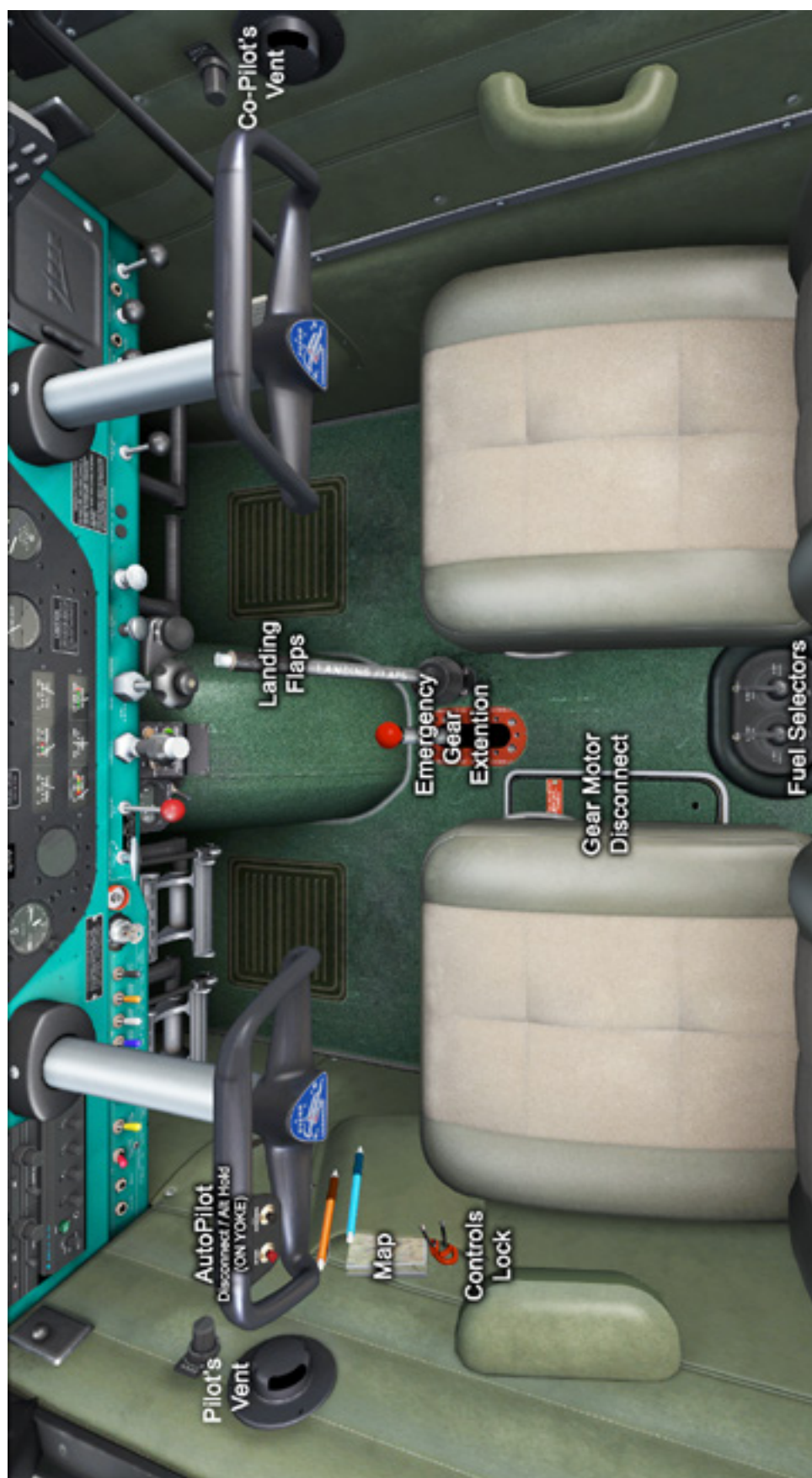
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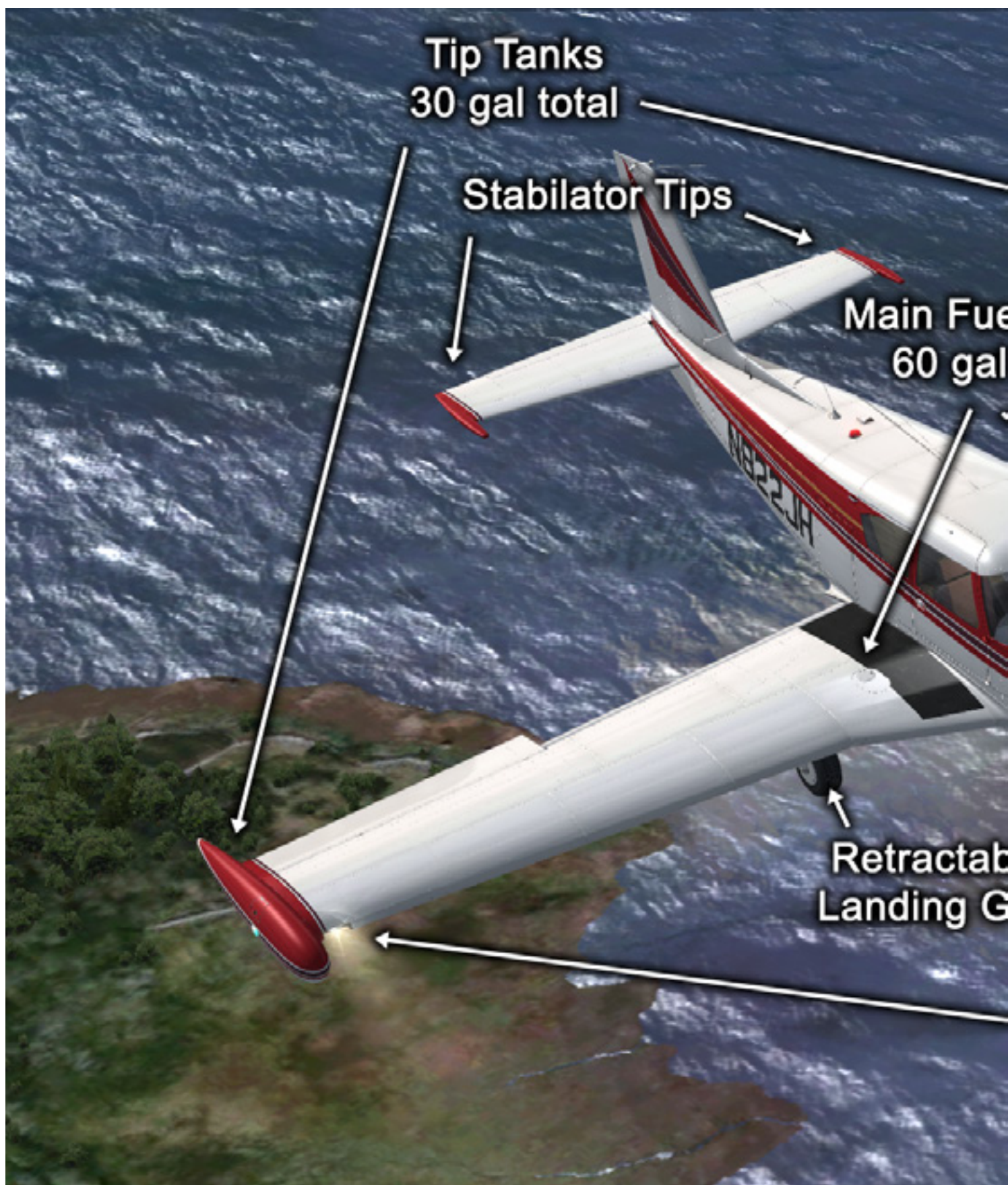
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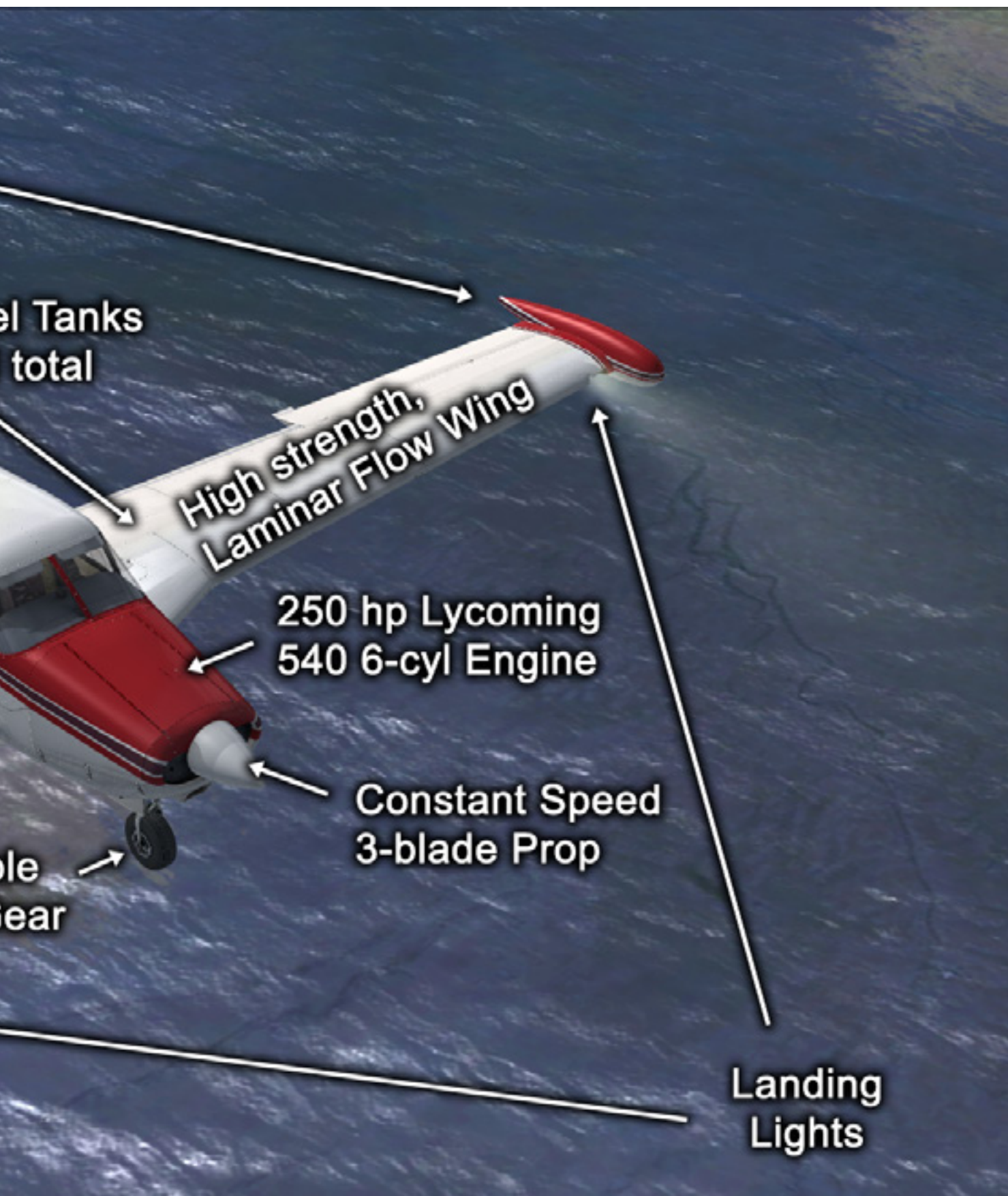


AIRPLANE & SYSTEM DESCRIPTIONS









EMERGENCY PROCEDURES



THIS SECTION CONTAINS PROCEDURES THAT ARE RECOMMENDED if an emergency condition should occur during ground operation, take-off, or in flight. These procedures are suggested as the best course of action for coping with the particular condition described, but are not a substitute for sound judgment and common sense. Since emergencies rarely happen in modern aircraft, their occurrence is usually unexpected, and the best corrective action may not always be obvious. Pilots should familiarize themselves with the procedures given in this section and be prepared to take appropriate action should an emergency arise.

Most basic emergency procedures, such as power off landings, are a normal part of pilot training. Although these emergencies are discussed here, this information is not intended to replace such training, but only to provide a source of reference

and review, and to provide information on procedures that are not the same for all aircraft. It is suggested that the pilot review standard emergency procedures periodically to remain proficient in them.

ENGINE POWER LOSS DURING TAKEOFF

1. If sufficient runway remains for a normal landing, leave gear down and land straight ahead.
2. If insufficient runway remains:
 - a. Airspeed — Maintain Safe Airspeed
 - b. Landing Gear — As Situation Requires
 - c. Flaps — As Situation Requires
3. If sufficient altitude has been gained to attempt a restart:
 - a. Maintain safe airspeed.
 - b. Fuel selector — Switch to tank containing fuel
 - c. Electric fuel pump — **ON**
 - d. Mixture — Check **RICH**
 - e. Alternate air — **OPEN**
4. If power is not regained, proceed with power off landing.

ENGINE POWER LOSS IN FLIGHT

1. Airspeed — Establish Best Glide Speed (100 mph @ Full Gross Weight)
2. Fuel selector — switch to tank containing fuel
3. Electric fuel pump — **ON**
4. Mixture — **RICH**
5. Carburetor Heat — **ON**
6. Primer — Check In and Locked
7. Magnetos — left/right/both if no change
8. Engine gauges — check for indication of cause of power loss
9. If no fuel pressure is indicated, check tank selector position to be sure it is on a tank containing fuel.
 - a. When power is restored: Carburetor Heat — **OFF**
 - b. Electric fuel pump — **OFF**
10. If power is not restored, prepare for power off landing
 - a. Trim for 97 MPH.

POWER OFF LANDING

1. Trim for 97 MPH.
2. Locate suitable field.
3. Establish a spiral pattern.
4. Transponder to 7700. Radio to 121.5 and broadcast Mayday.
5. 1000 ft. above field at downwind position for normal landing approach. When field can be easily reached, extend gear, flaps and slow to 87 MPH for shortest landing.

GEAR DOWN EMERGENCY LANDING

1. Touchdowns should normally be made at lowest possible airspeed with full flaps.
2. When committed to landing:
3. Landing gear selector — **DOWN**
4. Throttle — **CLOSE**
5. Mixture — **IDLE CUT-OFF**
6. Ignition — **OFF**
7. Master switch — **OFF**
8. Fuel selector — **OFF**
9. Seat belt and harness — Tight
10. Door — Unlatch

GEAR UP EMERGENCY LANDING

1. In the event a gear up landing is required, proceed as follows:
2. Flaps — As desired
3. Throttle — Close
4. Mixture — Idle cut-off
5. Ignition switch — **OFF**
6. Master switch — **OFF**
7. Fuel selector — **OFF**
8. Seat belt and harness — Tight
9. Contact surface at minimum possible airspeed.
10. Door — Unlatch

FIRE IN FLIGHT

1. Source of fire — Check
2. Electrical fire (smoke in cabin):
 - a. Master switch — **OFF**
 - b. Generator Circuit Breaker — Pull
 - c. Vents — **OPEN**
 - d. Door (As Required) — **OPEN** as an Exhaust
 - e. Cabin heat — **OFF**
 - f. Land as soon as practicable..
3. Engine fire:
 - a. Fuel selector — **OFF**
 - b. Throttle — **CLOSED**
 - c. Mixture — Idle cut-off
 - d. Electric fuel pump — Check **OFF**
 - e. Heater and defroster — **OFF**
 - f. Proceed with power off landing procedure.

HIGH OIL TEMPERATURE

1. Power — Reduce
2. Mixture — Enrich
3. Airspeed — Maintain above 120 mph
4. Land at nearest airport and investigate the problem.
5. Prepare for a power off landing.

LOSS OF OIL PRESSURE

1. Land as soon as possible and investigate cause.
2. Prepare for power off landing.

LOSS OF FUEL PRESSURE

1. Electric fuel pump — **ON**
2. Fuel selector — Check on full tank
3. If the fuel pressure does not come back in a few seconds, change to another tank with fuel.
4. Land as soon as possible. Low fuel pressure may indicate a fuel leak.

CAUTION: If normal engine operation and fuel flow is not immediately re-established, the electric fuel pump should be turned off. The lack of a fuel flow indication while in the ON position could indicate a leak in the fuel system, or fuel exhaustion

HIGH CYLINDER HEAD TEMPERATURE

Excessive cylinder head temperature may parallel high oil temperature. The procedure for handling it is the same. Refer to High Oil Temperature procedure.

ALTERNATOR FAILURE

1. Verify failure
2. Reduce electrical load as much as possible.
3. Alternator circuit breakers — check
4. Alt switch — **OFF** 1 second then on
5. If no output:
 - a. Alt switch — **OFF**
 - b. Reduce electrical load and land as practical.

SPIN RECOVERY

1. Throttle — **IDLE**
2. Ailerons — **NEUTRAL**
3. Rudder — Full opposite to direction of rotation
4. Control wheel — Full forward
5. Rudder — Neutral when rotation stops
6. Control wheel — Smoothly regain level flight altitude

CARBURETOR ICING

1. Carburetor Heat — **ON**
2. Mixture — Max smoothness

ENGINE ROUGHNESS

1. Carburetor heat — **ON**
2. If roughness continues after one min:
 - a. Carburetor heat — **OFF**
 - b. Mixture — Max smoothness
 - c. Electric fuel pump — **ON**
 - d. Fuel selector — Switch tanks
 - e. Engine gauges — Check
 - f. Magneto switch — “**L**” & “**R**” then **BOTH**

If operation is satisfactory on either one, continue on that magneto at reduced power and full “**RICH**” mixture to first airport. Prepare for power off landing

OPEN DOOR

If the latch opens, the door will trail slightly open and airspeeds will be reduced slightly. Fly the airplane and return to land.

PROPELLER OVERSPEED

1. Throttle — Retard
2. Oil pressure — Check
3. Prop control — Full **DECREASE** rpm, then set if any control available
4. Airspeed — Reduce
5. Throttle — As required to remain below red line

EMERGENCY LANDING GEAR EXTENSION (DISCUSSION ONLY)

Prior to emergency extension procedure:

1. Master switch — Check **ON**
2. Circuit breakers — Check
3. Instrument lights — **OFF** (in daytime)
4. Gear indicator bulbs — Check
5. To extend the gear, remove the plate covering the emergency disengage control and proceed in these steps as listed:
 - a. Reduce power - Airspeed 100 MPH or below.
 - b. Gear selector “down locked” position
 - c. Disengage motor - raise motor release arm and push forward through full travel.
 - d. Rotate gear extension handle **FULL FORWARD** to extend landing gear and engage emergency safety lock. Pull aft on the handle to check that the safety lock is engaged.
 - e. **HANDLE LOCKED** in full forward position indicates landing gear is down and emergency safety lock engaged. Gear “down locked” indicator light should be ON. Proceed to land normally.

NOTE: In the simulator, the above emergency landing gear extension is accomplished by clicking on the red knob on the emergency landing gear extension handle.

EMERGENCY PROCEDURES EXPLAINED



THE FOLLOWING PARAGRAPHS ARE PRESENTED TO SUPPLY additional information for the purpose of providing the pilot with a more complete understanding of the recommended course of action and probable cause of an emergency situation.

ENGINE POWER LOSS DURING TAKEOFF

The proper action to be taken if loss of power occurs during takeoff will depend on the circumstances of the particular situation.

If sufficient runway remains to complete a normal landing, keep the landing gear down and locked, and land straight ahead.

If insufficient runway remains, maintain a safe airspeed and make only a shallow turn if necessary to avoid obstructions. Use of flaps depends on the circumstances. Normally, flaps should be fully extended for touchdown.

If sufficient altitude has been gained to attempt a restart, maintain a safe airspeed and switch the fuel selector to another tank containing fuel. Check the electric fuel pump to ensure that it is "ON" and that the mixture is "RICH." The carburetor heat should be "ON" and the primer checked to ensure that it is locked.

If engine failure was caused by fuel exhaustion, power will not be regained after switching fuel tanks until the empty fuel lines are filled. This may require up to ten seconds.

If power is not regained, proceed with the Power Off Landing procedure.

ENGINE POWER LOSS IN FLIGHT

Complete engine power loss is usually caused by fuel flow interruption and power will be restored shortly after fuel flow is restored. If power loss occurs at a low altitude, the first step is to prepare for an emergency landing. An airspeed of at least 90 MPH (for best endurance, 105 MPH for best distance) should be maintained.

If altitude permits, switch the fuel selector to another tank containing fuel and turn the electric fuel pump "ON." Move the mixture control to "RICH" and the carburetor heat to "ON." Check the engine gauges for

an indication of the cause of the power loss. Check to ensure the primer is locked. If no fuel pressure is indicated, check the tank selector position to be sure it is on a tank containing fuel.

When power is restored move the carburetor heat to the "OFF" position and turn "OFF" the electric fuel pump. If the preceding steps do not restore power, prepare for an emergency landing.

If time permits, turn the ignition switch to "L" then to "R" then back to "BOTH." Move the throttle and mixture control levers to different settings. This may restore power if the problem is too rich or too lean a mixture or if there is a partial fuel system restriction. Try other fuel tanks. Water in the fuel could take some time to be used up, and allowing the engine to windmill may restore power. If power is due to water, fuel pressure indications will be normal.

If engine failure was caused by fuel exhaustion power will not be restored after switching fuel tanks until the empty fuel lines are filled. This may require up to ten seconds. If power is not regained, proceed with the Power Off Landing procedure.

POWER OFF LANDING

If loss of power occurs at altitude, trim the aircraft for best gliding angle 90 MPH (if equipped, Air Cond. Off) and look for a suitable field. If measures taken to restore power are not effective, and if time permits, check your charts for airports in the immediate vicinity: it may be possible to land at one if you have sufficient altitude. The glide ratio is reduced dramatically when the landing gear is lowered.

REAL WORD TIP: If possible, notify the FAA by radio of your difficulty and intentions. If another pilot or passenger is aboard, let him help.

EMERGENCY PROCEDURES EXPLAINED

When you have located a suitable field, establish a spiral pattern around this field. Try to be at 1,000 feet above the field at the downwind position, to make a normal landing approach. When the field can easily be reached, slow to 85mph with flaps down for the shortest landing. Excess altitude may be lost by widening your pattern, using flaps or slipping, or a combination of these.

Touchdown should normally be made at the lowest possible airspeed. When committed to a landing, close the throttle control and shut “OFF” the master and ignition switches. Flaps may be used as desired.

Turn the fuel selector valve to “OFF” and move the mixture to idle cut-off. The seat belts and shoulder harness (if installed) should be tightened. Touchdown should be normally made at the lowest possible airspeed.

FIRE IN FLIGHT

The presence of fire is noted through smoke, smell, and heat in the cabin. It is essential that the source of the fire be promptly identified through instrument readings, character of the smoke, or other indications since the action to be taken differs somewhat in each case. Check for the source of the fire first.

If an electrical fire is indicated (smoke in the cabin), the master switch should be turned “OFF.” The cabin vents should be opened and the cabin heat turned “OFF.” A landing should be made as soon as possible.

If an engine fire is present, switch the fuel selector to “OFF” and close the throttle. The mixture should be at idle cut-off. Turn the electric fuel pump

“OFF.” In all cases, the heater and defroster should be “OFF.” If radio communication is not required, select master switch “OFF.” Proceed with power off landing procedure.

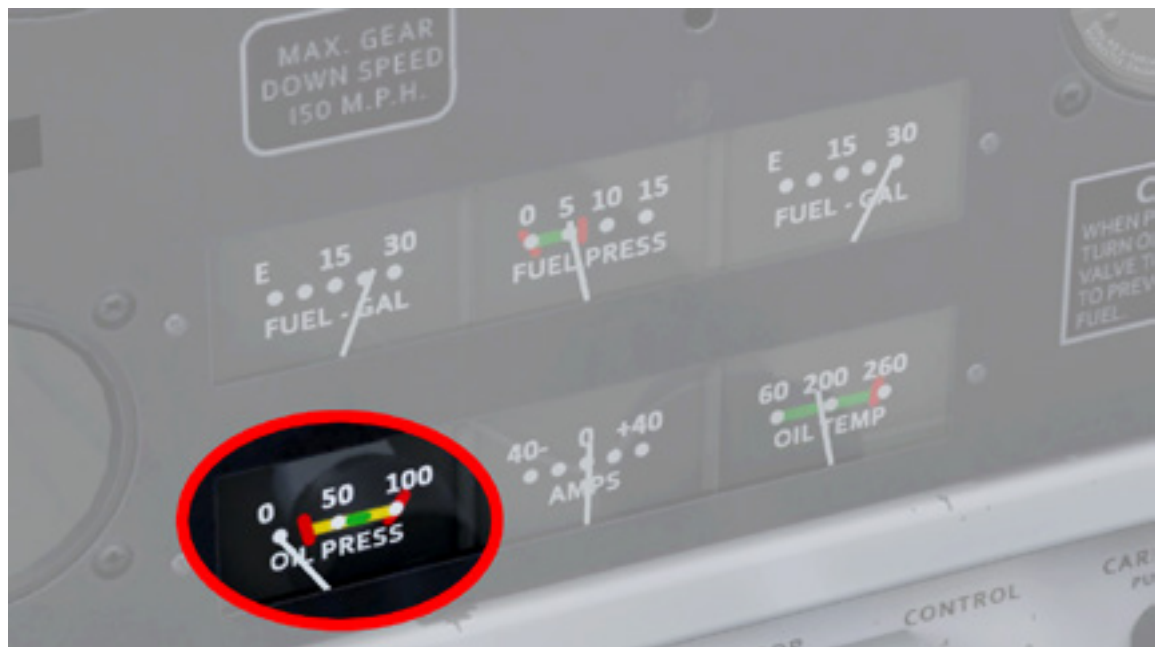
NOTE: The possibility of an engine fire in flight is extremely remote. The procedure given is general and pilot judgment should be the determining factor for action in such an emergency.

LOSS OF OIL PRESSURE

Loss of oil pressure may be either partial or complete. A partial loss of oil pressure usually indicates a malfunction in the oil pressure regulating system, and a landing should be made as soon as possible to investigate the cause and prevent engine damage.

A complete loss of oil pressure indication may signify oil exhaustion or may be the result of a faulty gauge. In either case, proceed toward the nearest airport, and be prepared for a forced landing. If the problem is not a pressure gauge malfunction, the engine may stop suddenly. Maintain altitude until such time as a dead stick landing can be accomplished. Don't change power settings unnecessarily, as this may hasten complete power loss. Depending on the circumstances, it may be advisable to make an off airport landing while power is still available, particularly if other indications of actual oil pressure loss, such as sudden increases in temperatures, or oil smoke, are apparent, and an airport is not close.

If engine stoppage occurs, proceed with Power Off Landing.



LOSS OF FUEL PRESSURE

If loss of fuel pressure occurs, turn “ON” the electric fuel pump and check that the fuel selector is on a full tank. If the problem is not an empty tank, land as soon as practical and have the engine-driven fuel pump and fuel system checked.

HIGH OIL TEMPERATURE

An abnormally high oil temperature indication may be caused by a low oil level, an obstruction in the oil cooler, damaged or improper baffle seals, a defective gauge, or other causes. Land as soon as practical at an appropriate airport and have the cause investigated.

A steady, rapid rise in oil temperature is a sign of trouble. Land at the nearest airport and let a mechanic investigate the problem. Watch the oil pressure gauge for an accompanying loss of pressure.

ALTERNATOR FAILURE

Loss of alternator output is detected through zero reading on the ammeter. Before executing the following procedure, ensure that the reading is zero and not merely low by actuating an electrically powered device, such as the landing light. If no increase in the ammeter reading is noted, alternator failure can be assumed. The electrical load should be reduced as much as possible. Check the alternator circuit breakers for a popped circuit.

The next step is to attempt to reset the overvoltage relay. This is accomplished by moving the “ALT” switch to “OFF” for one second and then to “ON.” If the trouble was caused by a momentary overvoltage condition (16.5 volts and up) this procedure should return the ammeter to a normal reading. If the ammeter continues to indicate (0) output, or if the alternator will not remain reset, turn off the “ALT” switch, maintain minimum electrical load and land as soon as practical. All electrical load is being supplied by the battery.

SPIN RECOVERY

Intentional spins are prohibited in this airplane. If a spin is inadvertently entered, immediately move the throttle to idle and the ailerons to neutral.

Full rudder should then be applied opposite to the direction of rotation followed by control wheel full forward. When the rotation stops, neutralize the rudder and ease back on the control wheel as required to smoothly regain a level flight attitude.

CARBURETOR ICING

Under certain moist atmospheric conditions at temperatures of -5 to 20 degrees C, it is possible for ice to form in the induction system, even in summer weather. This is due to the high air velocity through the carburetor venturi and the absorption of heat from this air by vaporization of the fuel.

To avoid this, carburetor preheat is provided to replace the heat lost by vaporization. Carburetor heat



should be full on when carburetor ice is encountered. Adjust mixture for maximum smoothness.

ENGINE ROUGHNESS

Engine roughness is usually due to carburetor icing which is indicated by a drop in manifold pressure, and may be accompanied by a slight loss of airspeed or altitude. If too much ice is allowed to accumulate, restoration of full power may not be possible; therefore, prompt action is required.

Turn carburetor heat on. Manifold pressure will decrease slightly and roughness will increase. Wait for a decrease in engine roughness and an increase in manifold pressure, indicating ice removal. If no change in approximately one minute, return the carburetor heat to “OFF.”

If the engine is still rough, adjust the mixture for maximum smoothness. The engine will run rough if too rich or too lean. The electric fuel pump should be switched to “ON” and the fuel selector switched to the other tank to see if fuel contamination is the problem. Check the engine gauges for abnormal readings. If any gauge readings are abnormal, proceed accordingly. Move the magneto switch to “L” then to “R,” then back the “BOTH.” If operation is satisfactory on either magneto, proceed on that magneto at reduced power, with mixture full “RICH,” to a landing at the first available airport. If roughness persists, prepare for a precautionary landing at pilot’s discretion.

NOTE: Partial carburetor heat may be worse than no heat at all, since it may melt part of the ice, which will refreeze in the intake system. When using carburetor heat, therefore, always use full heat, and when ice is removed return the control to the full cold position.

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.

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 the Federal Aviation Administration.

AIRPLANE HANDLING, SERVICE & MAINTENANCE

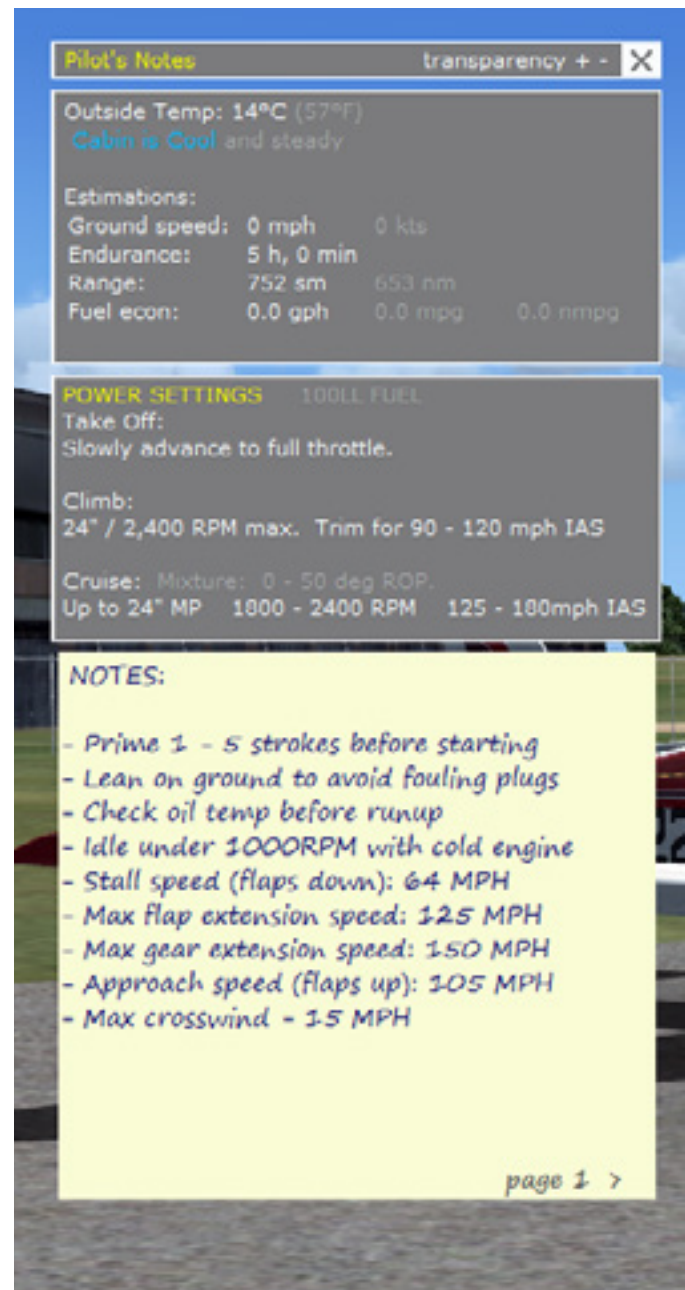
2D PANELS

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.



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.

AIRPLANE HANDLING, SERVICE & MAINTENANCE



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.

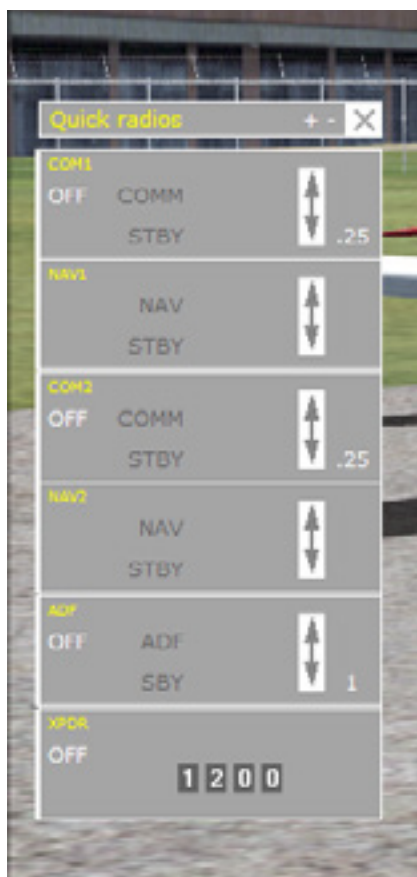
Also note that some of the button selections have an increasing amount of information presented with each subsequent button press.

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.

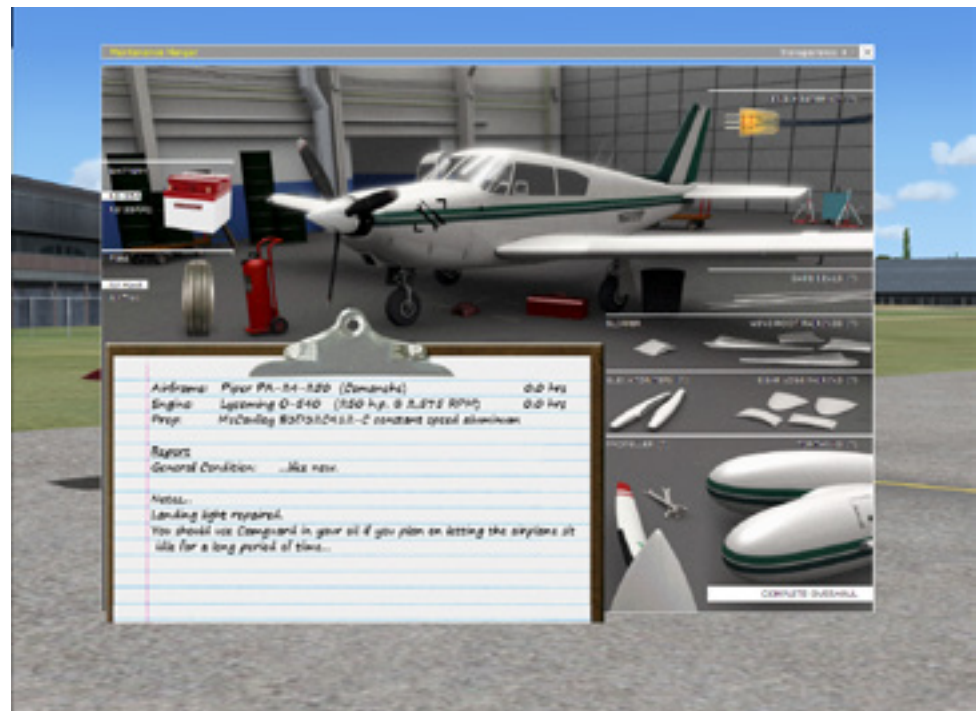
The compressed air would then pass through a calibrated restrictor and to the cylinder pressure gauge. This gauge would show the actual air pressure within the cylinder.

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 RPM’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.



AIRPLANE HANDLING, SERVICE & MAINTENANCE



Pre-Flight Inspection (Shift 8)

The Pre-Flight Inspection is another advancement in bringing real life standard operating procedures into Prepar3D.

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 right wing. 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 tail.

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.



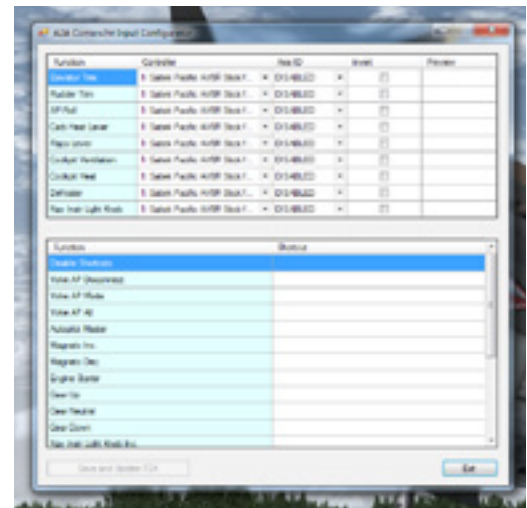
Input Configurator

The Input Configurator allows users to assign keyboard or joystick mappings to many custom functions that can't be found in Prepar3D controls assignments menu. It can be found in the A2A/COMANCHE250/Tools folder inside your Prepar3D 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 Comanche 250 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 Comanche 250.

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