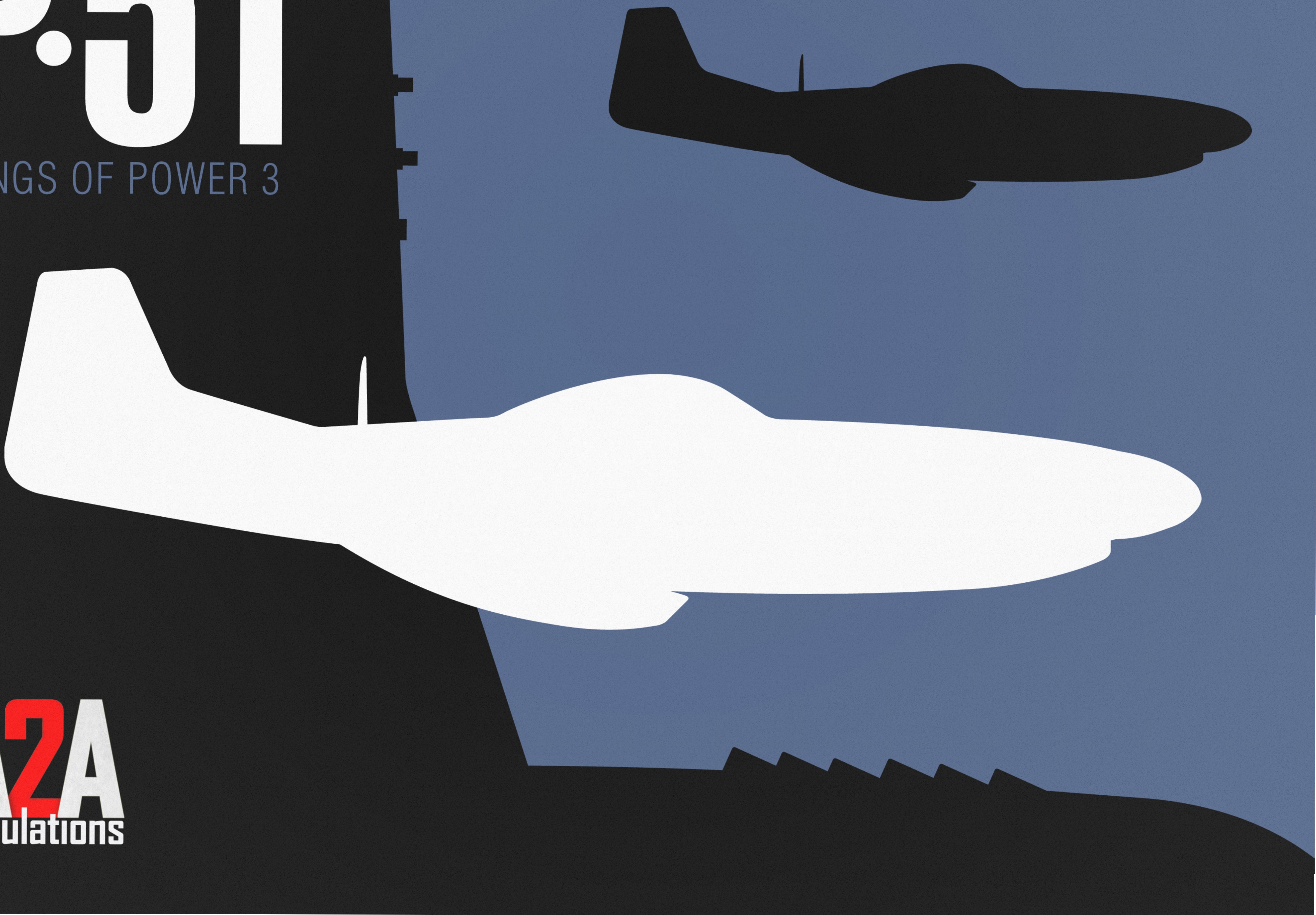
P-51

WINGS OF POWER 3



A2A simulations

Wings of POWER III “P-51”

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Risks & Side Effects

Ergonomic Advice

- Always maintain a distance of at least 45 cm 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 90º.
- 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.

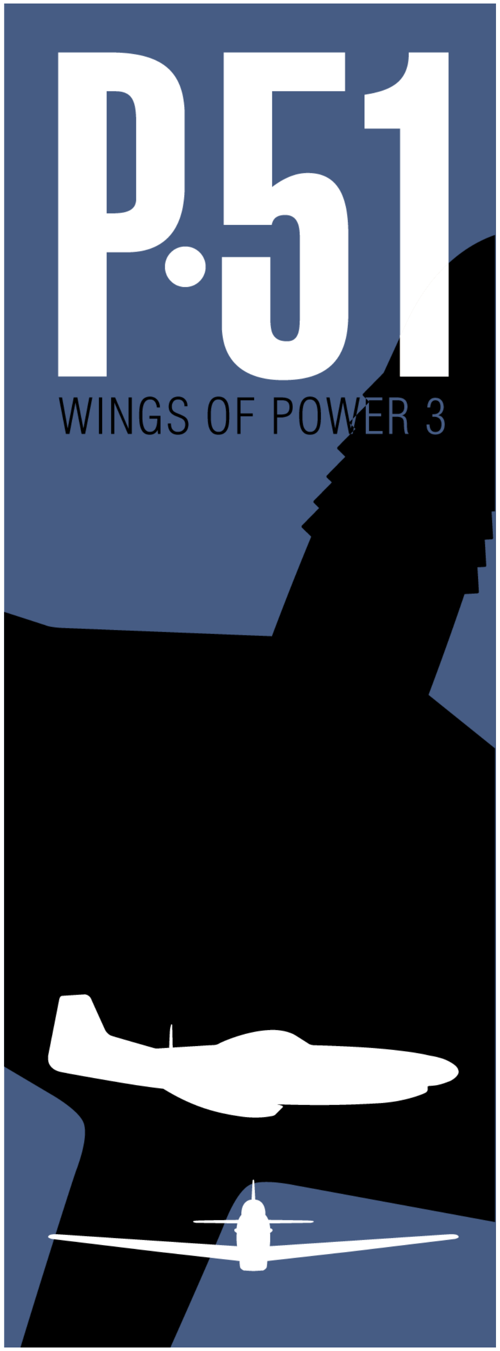
A2A simulations

"Passion for Flight"

Wings of POWER 3

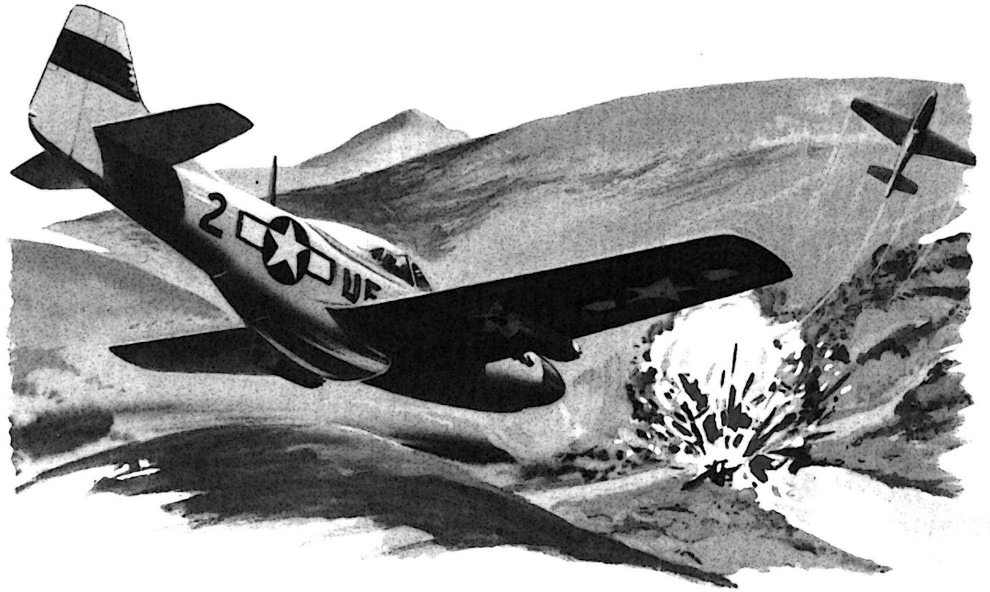
"We put you in the cockpit of some of the worlds most exciting aircraft."

Contents



Emotion in Metal

Foreword



Few planes in history when their names are spoken provide the listener with a mind's eye image of the aircraft. Even fewer evoke emotion. An even smaller percentage of this prestigious crowd is a true testament to the nations that developed them. If someone was asked to name the most widely known aircraft developed for each nation during hostilities in World War II, a short but concise list could be drawn. For Japan, the highly maneuverable wonder plane, the Mitsubishi A6M Zero would undoubtedly be picked. Britain's aircraft would likely be one of the most beautiful, elegant and efficient aircraft designs in the world, the Supermarine Spitfire. For Germany, one has to look no further than the menacing and highly coveted Messerschmitt Bf 109. For the United States of America the aircraft that manages to capture the American spirit with its polished aluminum skin and sweeping silhouette is the North American Aviation P-51 Mustang.

As a young child my parents would sometimes take me to the local air show and I would watch in amazement and awe as these aircraft would perform their daring feats. The crowd would gasp as they would perform stunts so hair raising that you undoubtedly believed the pilots were moments away from crashing. Unfortunately I can only remember a few of those stunts, but generally speaking, none of the aircraft that performed them. There was one notable exception. My six year old self was standing against the fence as a group of aircraft performed a simulated ground attack with which pyrotechnics were used. As the planes flew low approaches over the runway, large mushrooms of fire erupted from the grass close enough that I could feel the heat kissing my face. Through one such pass, a plane flew close enough to the explosion that the prop caused the resulting cloud of thick black smoke to swirl around the prop and dance about against the blue backdrop of sky. Then the absolute unthinkable happened. As I stood pressed up against the fence, the pilot locked eyes with me, waving in a low pass. For a moment I was absolutely sure this pilot was performing this show solely for myself and the sound of the audience seemed to disappear to where I could only hear the sound of that engine growling intensely enough to be felt inside my heart.

I had never seen such a plane in my entire young life! It was a beautiful, highly reflective metal aircraft with bright colors draped across it in shapes and patterns which caught the eye of this young man. It was complete magic and I was pressing so hard against the fence as to cause a ground crew member to snap me back to reality by asking me to step back. I looked at my parents with large eyes and a gaping mouth and excitedly asked them what the aircraft was. They did not know, but told me that they would take me to see it later during a break. I can't seem to recall much happening in the air beyond that point, but not for lack of aerobatic displays. Simply put, I was so engrossed in that plane and the pilot I saw that nothing quite lived up to that experience.

My parents made good on their word and eventually some time later we walked through the crowd to the aircraft displays. I was halfway across the field when I saw that beautiful colored nose and polished aluminum frame when I bolted from besides my parents, much to their chagrin. I must have looked like a lunatic as I ran up to the aircraft and stood in front of the pilot as my parents frantically ran trying to catch up to me screaming my middle name. I didn't say anything, but the pilot smiled down upon me and asked if those were my parents. I nodded, still keeping my eyes fixated on that pilot and mouth probably still half open. He told me that the aircraft was the "Mustang," although I don't recall what else he said. When my parents finally caught up to me my mother grabbed me by the ear and sternly warned me about the virtues of staying close to them in large crowds. The pilot, probably amused by the whole situation did the second thing I will never forget as he asked me if I would like to stand on the plane and look into the cockpit. Of course I did, and I looked over every inch of that aircraft and its cockpit as my parents stood on, clearly bored but amused that for a moment they could keep me in one place without alarms going off or expensive things being broke. The pilot spoke to my parents but kept an eye on me.

I began my fascination with what I believe was the most beautiful aircraft ever built when I was six years old. Today, whenever I see the Mustang I am transported to that day of innocence and I feel young again, with that plane representative of a deep seated love I now have in warbirds. While some may disagree with my personal taste, my story is not unlike tens of thousands of other young kids who first fell in love with the venerable P-51 Mustang. This was the first aircraft I knew by name and sight. Much like your first true love, the first car you own or one of those special bonding moments when your father takes you fishing, this plane to me holds a special love that is timeless and emotionally charged.

History of the North American P-51 Mustang

The P-51 is truly a testament to American ingenuity, drive and engineering with additional strokes of good luck. In some ways it's a bit of a Cinderella story in that the success it finally earned was not fully expected, nor designed to be so upon the outset of its inception. The story of the Mustang actually goes back to 1938 when the British Purchasing Commission led by Sir Henry Self was sent to the United States with its objective to purchase military aircraft as Britain began to gear up for the impending war with Germany. Although America was invested heavily in isolationism and neutrality in regards to other nation's affairs, at the time there were no laws barring the sale of military equipment to nations that were not at war. Among the purchases made, the British Purchasing Commission bought the T-6 Texan (known as the Harvard in the British Commonwealth air forces). This helped solidify North American Aviation's position as one of the primary military aircraft builders in the United States.

During 1939 when Britain officially involved in war with Germany, an embargo was placed on the exportation of military equipment. An act passed by Congress allowed the British to continue receiving the equipment however if they were shipped in their own merchant vessels allowing the acquisition of such equipment to continue. While going slightly beyond the scope of this article, it should be known that during this period North American Aviation was punctual and highly efficient when providing Britain and her allies with the goods needed to continue the war effort, hence why the British Purchasing Commission approached them to produce the Curtiss P-40 Warhawk (known in the RAF as the Tomahawk). The Curtis P-40 was suitable for ground attack missions and the Allison 1710 engine which powered it was reliable and well built, although it was not supercharged which significantly reduces the aircrafts effectiveness at higher altitudes. The Commission knew full well the limitations of the P-40 but proceeded forward regardless and ordered over 1,700 aircraft for use by British and French forces.

North American Aviation saw an opportunity in a stroke of keen business acumen and proposed to build a whole new plane which was designed to outperform the P-40. John Kindelberger (the President of NAA) and James Atwood (former Chief Engineer and current Vice President of NAA) gave their proposal to Colonel William Cave and Air Commodore G B A Baker of the Commission, to which it was well received. James Atwood was then summarily sent to meet with Sir Henry Self and signed a draft contract for 320 NA-73 (then the aircraft's designation) fighter aircraft. There was a caveat however and that was time. Self's decision had a significant amount of faith placed behind it considering the aircraft had not yet been designed. On April 24th the engineers at Inglewood (North American Aviation's facility) began drawing up designs. Overnight plans were made by Edgar Schmued (Chief Designer) and Raymond Rice (Chief Engineer) and were sent to Atwood. He then presented them to the Commission who approved the contract for 320 aircraft on May 29th 1940.

The biggest stipulations for the order was that the prototype aircraft was to be available by the time it would have taken North American Aviation to tool up for production of the P-40 (120 days) and the cost was to not exceed $50,000 per unit. In a Herculean effort North American Aviation went to work and the wheels of industry began turning. Originally the Allison 1710 was going to be the engine utilized for production, and efforts to create as low a drag airframe as possible were made. Even a relatively new wing structure was going to be used which was known as the laminar flow section wing designed by NACA (National Advisory Committee for Aeronautics).

Up to that point it was common for wing designs to have maximum chord thickness near the edge (front) of the wing structure. The laminar flow wing however placed this well aft of conventional wings thus allowing the laminar flow to be maintained longer before turbulence was created, further maintaining the boundary layer and reducing drag. Original designs did not call for the NA-73 aircraft to be married to the laminar flow wing, but Ed Horkey and his team produced convincing studies, thus it was adopted. Unfortunately initial scale wind tunnel tests proved to be disastrous as the stalling behavior was unsatisfactory. When further tests were conducted in a much larger wind tunnel in Seattle, Washington the results proved that initial observations regarding wingtip turbulence had in fact been misleading.

North American Aviation was abuzz with energy. Everyone was bustling to meet the initial 120 day deadline and things were happening fast. Castings were created for mass production methods and mockups of the assemblies were created. On August 30th, 1940 the first prototype was wheeled off the production floor (without its engine as Allison was suffering from production delays), and it was done so in 117 days. So impressed with the design the British Purchasing Commission purchased an additional 300 aircraft.

At the hands of Chief Test Pilot Vance Breeze, NA-73X with serial number NX 19998 lifted off the ground at Mines Field. With only a few heating issues, the reports were quite satisfactory for the initial flights. On the fifth flight however test pilot Paul Balfour crashed the aircraft onto its back but escaped uninjured. The problem was found to be an error during the switching of fuel tanks, and the forced landing that occurred found the plane touching down on soft ground which caused it to overturn.

The accident however did not stop the forward progress that was being made and production started on the 620 machines that the Commission had ordered. She was also given a name, the Mustang, which is appropriate considering the American ancestry and performance. The first Mustang (serial AG 346) to arrive in Britain fell under the then Lend-Lease Bill and were unloaded on October 24th 1941 at Liverpool, assembled then flown in November. The first production Mustang (serial AG 345) however stayed in the United States for testing.

British testing showed that the Mustang I was a very pleasant aircraft which was a mix of high speed (375MPH at 15,000 feet) and maneuverability. At the time, the Mustang outpaced even the outstanding Spitfire design by a clear 35 MPH at the same altitude, but the Spitfire had higher rate of climb and the Mustangs performance dropped off drastically at altitudes higher than 12,000 feet with speeds of roughly 350 MPH at 21,000 feet. This caused concern naturally for pilots flying against the superior altitude fighter the Messerschmitt Bf 109. In plain terms, the Mustang performed best at lower altitudes, and thus it was given to Army Co-operation Command for use in close air support and photographic intelligence, an area to which the Mustang was well suited.

Several variants of these early Mustangs were produced. In Britain it was known as the Mustang I and Mustang IA respectively. A strictly fighter version was produced and ordered for the United States Army Air Corp and was designated the P-51A. 55 Mustang IAs were repossessed and fitted with American built cameras (of British design) and were used in North Africa in March 1943 carrying the Stars and Stripes on their tails. A version was even built as a dive bomber and designated the A-36A Apache, first flying in September 1942. These early Mustangs proved valuable in their role, being fast and maneuverable at lower altitudes. Beyond this role however the Mustang struggled to find a home, but the seeds of excellence were already planted and the plane was proving itself to be exceptional, if not yet fully understood.

In April 1942 a test pilot by the name of Ronald Harker flew a Mustang I while evaluating various plane types of the allies and enemy. He was so impressed by the plane's handling that he suggested to the Chief Aerodynamic Engineer at Rolls-Royce, W Challier that if the new Merlin 61 (which was powering the prototype Spitfire IX) were married to the Mustang that its performance would be significantly increased. Challier estimated the aircraft and engine could achieve 441MPH at 25,600 feet. It's potential became blatantly obvious and excited the American Assistant Air Attaché Lieutenant Colonel Thomas Hitchcock, to which details were supplied to the USAAF's General Hap Arnold. Included were recommendations from senior RAF officers including Air Chief Marshal Sir Trafford Leigh-Mallory.

Rolls-Royce immediately began the conversion in June 1942 of four Mustangs. The four Mustang serial numbers were AM 203, AM 208, AL 963 and AL 975. AL 975 became the first converted but rather than using the Merlin 61, Rolls-Royce opted to utilize a Merlin 65 with a two-stage supercharger. On October 13th 1942 the newly converted AL 975 took to the air at the controls of Rolls-Royce Chief Test Pilot Ronald Shepard. Tests proved the concept and gradual changes were made to the airframe, propeller, intercooler exhaust, etc. until in November, 413 MPH was achieved. The test pilots noted significant differences the new engine made to the aircraft. Some found the earlier Allison equipped Mustangs to be more enjoyable to fly as they were more directionally stable and didn't stall quite as violently. As tests continued into 1943 the performance of the new marriage improved time to 20,000 feet to just over an outstanding six minutes, compared to over nine minutes for the Mustang I.

Back in the United States changes were being made to the assembly lines to introduce the new Packard Merlin V-1650-3 (the American designation for a U.S. built Merlin). Upon delivery to Britain tests were quickly conducted which satisfied General Hap Arnold and production of the P-51B commenced. Eventually in August 1943 a second North American Plant was opened in Dallas Texas and aircraft being produced in the facility were labeled as the P-51C-NT (whereas aircraft built at Inglewood in Los Angeles were labeled P-51B-NA. History had been born, and soon the Allies would be equipped with the aircraft to which they could take the fight directly to the Nazis.

Throughout early 1943 the various Air Forces were suffering incredible losses in bombing raids. Many American commanders were stout in their belief that B-17 Flying Fortress and B-24 Liberator bombers could fight their way in and out of Germany unassisted. Whether they wished to fly unassisted or not however didn't matter, as the range of the current escort fighters simply did not provide the bombers with the necessary air cover when flying long missions deep into Germany. Aircraft such as the stubby but rugged P-47 could not provide the range necessary to escort the bombers to and from the target, and often had to be scheduled to intercept the bomber formations on their return trip. The Luftwaffe took advantage of these moments without fighter cover to devastating effect. During one raid on a German ball-bearing factory on September 27th, 1943 of the 291 B-17s designated for the mission, 60 were shot down with an additional 138 damaged. The P-38, the only aircraft with enough range to assist the bombers unfortunately suffered from numerous problems in the European theater that did not exist in the Pacific. Poor speed performance compared to the Axis fighters, easy recognition, poor engine performance all lead to the aircraft eventually being withdrawn from such missions. Clearly a new aircraft was needed that could fight all the way into Germany and had the speed and maneuverability to protect their bigger brothers. The P-51B/C was clearly the answer but the demands of the 8th Air Force were not met until November 1943 when the first Group arrived.

While other aircraft could fly faster, higher or further than the P-51, the Mustang was able to accomplish all three in combination to a degree that no other plane could. With two 75 U.S. gallon drop tanks the range of the P-51B/C was an outstanding 1,800 miles. With the addition of the 85 U.S. gallon internal self-sealing fuselage tank (which sat behind the pilot), internal range without drop tanks was increased to a staggering 1,350 miles at 10,000 feet. Further, the P-51B/C models could achieve 440 MPH at 30,000 feet. The allies had found their plane to escort the heavy bombers, and the results were immediate. Losses among 8th Air Force bombers dropped dramatically as their little brothers hovered above their formations and dropped down upon their unsuspecting enemies spouting flames from their .50 caliber Browning machine guns.

In Italy the P-51s assigned to the 332nd Fighter Group helped earn their reputation as some of the finest airmen of the war. The 332nd FG consisted of volunteer African-American airmen and was notably known as the Tuskegee Airmen or "Red Tails" as they were often referred. Massive amounts of enemy aircraft were destroyed by the American units fighting in Italy flying the P-51 Mustang, and on one day of operations alone the 52nd FG destroyed over 150 enemy machines while strafing and passing time and again over the Luftwaffe airfield at Reghin in Romania.

In the Pacific, China and Burma the American Volunteer Group or "Flying Tigers" transitioned to the United States Army Air Force and their command. This was officially formed as the 14th Air Force and was part of the Chinese-American Composite Wing. In late 1944 this group turned over their aircraft and began receiving P-51 Mustangs. Several famous members of the AVG such as Tex Hill and Robert T. Smith eventually flew Mustangs as well, although not as part of the 14th FG. The P-51 was often tasked with escort missions on the newly developed B-29 bomber, but further participated in notable battles such as that of Iwo Jima and the defense of the Philippines.

Although the P-51B/C variants were highly successful, it was realized that there were issues that were starting to creep up. One of the first and major noticeable modifications of the newly designed D model Mustang was the redesigned canopy. Several B/C model Mustangs were being equipped with "bubble" canopies in the form of the Malcom Hood to help improve visibility. This however was not substantial enough and a further solution was needed. A new plexiglass canopy was designed by North American Aviation based upon new manufacturing techniques and technologies found while creating plexiglass windows for bombers. With the addition of this new bubble canopy, the aft fuselage was redesigned to give better visibility.

The wings of the new Mustang were slightly redesigned due to changes made to the landing gear up-locks and door retracting mechanism which changed the wing area. New positional lights were fitted and a new retractable landing light was fitted in the wheel wells. Two additional Browning M2 .50 caliber machine guns were fitted, bringing the total to six. Although the B/C models were eventually fitted with 85 U.S. gallon fuel tanks, the new design of the aft fuselage on the P-51D exacerbated the poor handling characteristics when this tank was installed and full. Due to this a dorsal fin was added to help stabilize the aircraft, being introduced towards the end of P-51D-5 production and being worked into manufacturing from that point forward. The cockpit layout was also significantly redesigned eventually from that of the original B/C and early D-5 models.

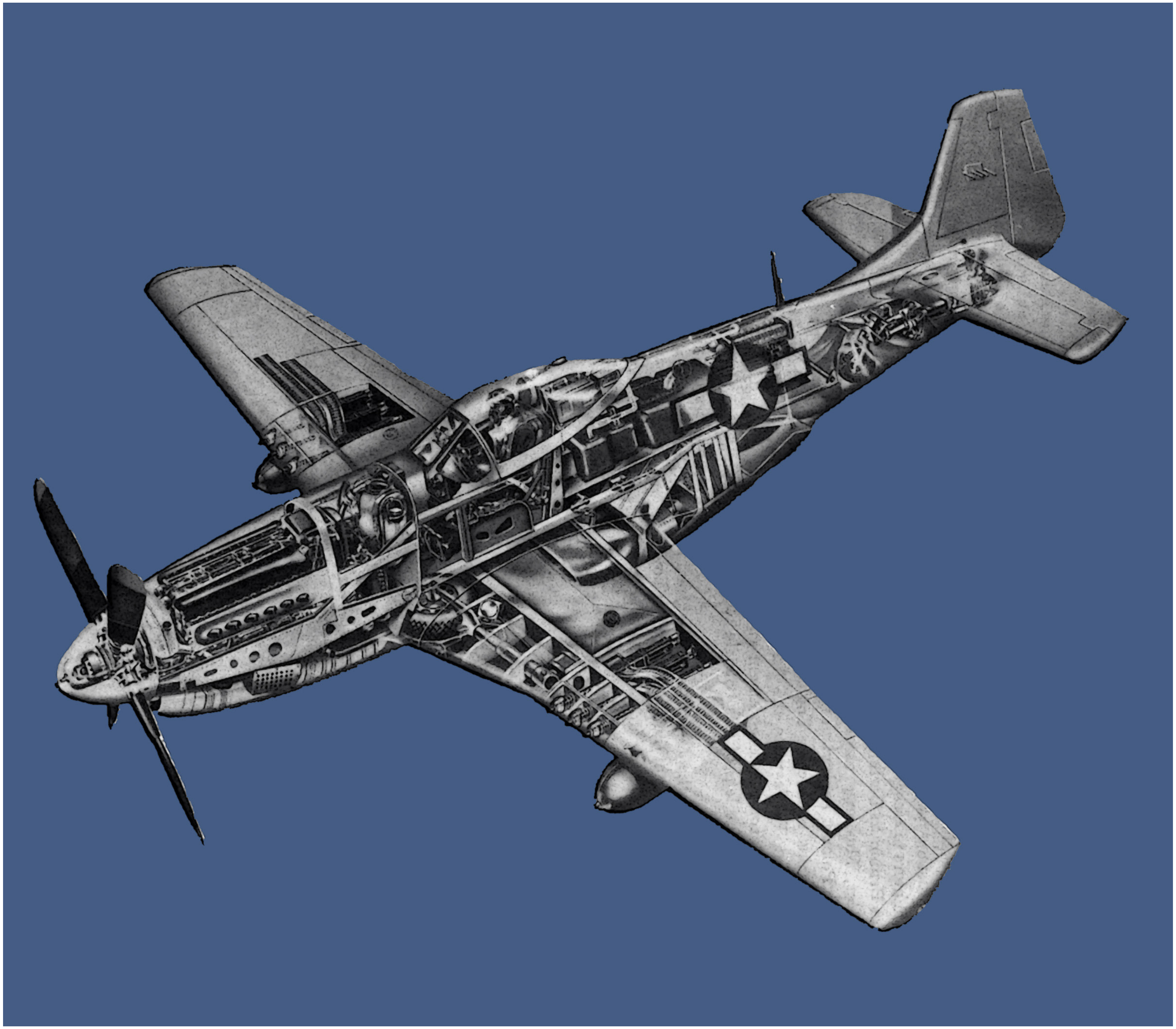
While the P-51 continued to be produced in various other forms, such as the faster lightweight P-51H and eventually the F-82 Twin Mustang, the D model Mustangs were produced in higher numbers than any other block or variant and mark the height of Mustang production at 8,102 aircraft built. The P-51D also served with the United States Air Force as the F-51 in Korea and throughout the world in reserve or National Guard units, COIN operations and other various roles well into the late 20th century which is a testament to its excellent performance.

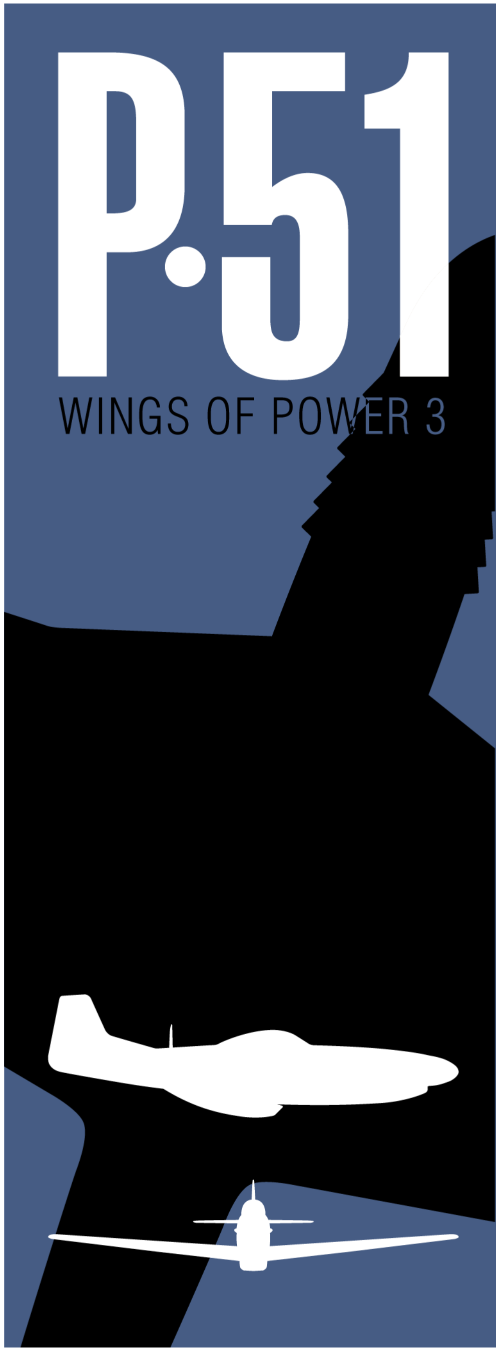
One point of particular interest is that many of the aircraft in the Wings of Power III lineup have played important roles in the history of the P-51 Mustang. If it wasn't for the Curtis P-40 Warhawk, the British Purchasing Commission would have never approached North American Aviation which is a strong testament to the original design that Curtis made. As the P-51 was being tested an engine already installed in Britain's superior Spitfire was selected to improve the Mustang's performance. As this performance was proven the P-51 began escorting the vulnerable B-17 formations into Germany and increasingly swapped roles with the P-47 from ground attack to escort. Even the designs of these aircraft play increasingly important roles in the P-51 Mustang. The P-51D uses a more sophisticated version of the constant RPM governor of the P-40. Also the design of the intake directly under the fuselage was efficient because of the increased airflow from the prop, versus the almost adequate cooling system of the early Spitfires. It also benefits greatly from the well built Rolls-Royce Merlin engines that go hand in hand with the Spitfire's reputation. The aircraft had a manifold pressure regulator system which resembles those used on the B-17. Lastly, the P-51 Mustang utilizes a two stage turbocharger and automated cooling doors which bear some resemblance to those of the P-47D, if only more simplified.

The P-51 Mustang is indeed a pilot's plane, but it has some nuances that are utterly unforgiving if not properly trained. Many of the systems on the P-51 are automated, allowing the pilot to focus on flying the aircraft versus managing its systems. She carries a lot of speed but in turn can be troublesome to slow down. She has more than enough power to get anyone out of trouble but enough to get you in trouble at the most inappropriate times. She also has significant vertical authority but has a nasty stall and spin should you push her beyond her limits, especially with fuel in the fuselage tank. She is well harmonized in all directions however and with proper trimming you can fly the P-51 with your fingertips while cruising. She can be a beauty and a beast all in one and was known to bite those who didn't understand her capabilities thoroughly, but in the right hands was more than a match for her most formidable enemies.

Some sources indicate that the P-51 destroyed over 5,900 enemy aircraft with a kill ratio of 11:1 in all theaters, making it easily the highest scoring American aircraft of the war above the extremely well built F6F Hellcat. It is also said that when Herman Goering (Reich Minister of Aviation and head of Luftwaffe) learned of the P-51s flying escort for the American bombers over Berlin that he told some of his staff, "The war is over." Truly, the North American Aviation P-51 Mustang is an American icon and deserves a spot as one of the most beautiful, highest performing and efficient aircraft developed during World War II and in some circles arguably the best fighter aircraft ever produced.

Cody Bergland





1 Introduction

DESIGNER'S NOTES:

The Mustang is a runner, and can fly high and fast. It is also arguably the finest fighter of World War II, not because of any single attribute, but rather the sum of all of it's qualities. Perhaps, most importantly, was it's long range which allowed it to escort allied bombers all the way to Berlin and back.

If you own either our Accu-Sim Spitfire or P-40 Warhawk, you are now stepping ahead to a late war design aircraft, with many systems that help relieve the pilot from performing many tasks you are probably already quite familiar with. The engine cooling flaps automatically adjust to changing conditions and the throttle holds the power based on your throttle position.

We made three separate trips to Mustangs flying today to capture first-hand data, take high resolution photos and videos, capture sounds, and record system behavior. We then use this hard data against research and documented flight tests available to the public. The end result, is an aircraft that flies the way it should based on both well known, and our own first-hand information.

The result, we hope, is the very finest reproduction possible in a flight simulator.

If you enjoy this aircraft and would like to elevate it to another level of authenticity, we encourage you to check out the Accu-Sim expansion pack for this airplane. Accu-Sim opens up a brand new world, taking you beyond what is possible with Prepar3D. It places you inside the most believable cockpit imaginable as it recreates every sound, nuance and characteristic of the airplane.

However, if you just like to step in, fire up the engine, throw the throttle forward and fly away while admiring a beautiful airplane, then Wings of Power is for you. We spent many many days and nights, making this aircraft look as great as we could make it.

A2A simulations

The Air to Air Simulations Team

Wings of Power 3: P-51 Mustang Features

- The world's most iconic WWII fighter aircraft
- As with every A2A aircraft, it is gorgeously constructed, inside and out, down to the last rivet.
- Designed and built to be flown "By The Book".
- Custom Cockpit Systems and Gauges.
- Visual Real-Time Load Manager, with the ability to load fuel and stores in real-time.
- Naturally animated pilot.
- 3D Lights 'M' (built directly into the model) with under-wing landing light that can be turned on, deployed, and retracted and fully functional recognition lights.
- Pure3D Instrumentation now with natural 3D appearance with exceptional performance.
- Sound engineered by A2A sound professionals.
- Oil pressure system models oil viscosity (oil thickness).
- Authentically modeled pneumatic system.
- In cockpit pilot's map for handy in-flight navigation.
- Auto-Mixture that actually performs as intended. Aircraft fuel-to-air ratio will be automatically determined and set by the carburetor based upon various factors, such as altitude.
- Dual speed, dual stage Supercharger modeled with accurate behavior.
- Fuel delivery system simulated.
- All models include A2A specialized materials with authentic metal.
- Pilot's Notes pop-up 2D panel keeps important information easily available.

General Operational Information and Guidelines

The following information is provided to help pilots become familiar with the Wings of Power series of aircraft for Lockheed Martin Prepar3D. These aircraft are materially different in terms of the flight modeling than what is commonly available. Be aware that what is generally accepted as standard performance or aircraft behavior, in many cases will not apply to these aircraft.

Why? Because Wings of Power aircraft are flight tested and tuned until they reflect the proper results throughout their entire performance envelope.

Flight simulation that goes beyond maximum performance figures

Many times, an aircraft is considered to fly accurately if it reproduces a handful of specific performance figures (top speed, max climb rate, stall speeds, etc.). These figures really only represent how an aircraft is performing at a single point in time. We push through these numbers and authentically simulate all flight through an almost unlimited amount of conditions.

As the pilot in command, you can take a Wings of Power aircraft to any given altitude, choose your own power setting (adjust the throttle and watch the manifold pressure / boost gauge), adjust your prop speed and witness your aircraft climb and cruise exactly as it did in real life. You will even experience accurate fuel consumption rates, engine temps, and stall characteristics. You can plan realistic and even historic flights based on your aircraft weight, and calculate cruise speeds, distances traveled, and even authentic figures like “distance-to-altitude” shown in the manuals. These figures are not just estimated, they are finely tuned and put through a rigorous and exhaustive testing process by pilots.

Every Wings of Power aircraft is test flown by the book with hand-drawn charts and passes a rigorous testing procedure before it is released to our beta testers. Among our testers are highly experienced real-world pilots who continue to push the aircraft through its paces. We encourage people to go out and buy the actual pilot training manuals for these aircraft and use them. When it comes to unique stall characteristics and other aspects not documented in the manuals, we refer to actual pilot flight-test reports and our own pilot interviews. The end result comes from a hard-working team effort. The bottom line is, for the first time ever, you can experience these thoroughbred aircraft today like it truly was and still is.

FULL POWER does not mean FULL THROTTLE

It is common in the flight simulation industry to accept that the maximum throttle setting (100 percent throttle) should reflect the published takeoff power of piston-engined aircraft. For example, the published takeoff power setting for the B-24D Liberator is 49" of manifold pressure and 2700 RPM. A standard P3D model of the B-24 would expect the pilot to simply shove the throttles and propeller controls to the stop and head for the wild blue yonder. This is just not the way things are in real life or with Wings of Power.

In reality, a real pilot would never under any circumstances shove the throttle all the way to the stop unless war emergency power was required and even in this case it would almost never mean throwing both boost and throttle to the extreme forward position. On takeoff, a pilot "walks" the throttle carefully but briskly forward until the proper takeoff power setting is reached. This setting is read on the manifold pressure gauges. Use the boost lever with extreme care, especially at low altitudes.

How long does it take to get airborne?

The takeoff distances are tested and compared against the performance tables for that airplane's respective pilot's training manual. However, to achieve these figures, the airplane must be flown exactly according to the procedure in the checklist. Using full throttle, incorrect flap positions, incorrect takeoff weights, erroneous trim settings, or improper liftoff technique will materially affect the takeoff distance.

The distances provided are the distances it takes to clear a 50' obstacle, which is a common pilot training procedure. These can be reduced by about 1/3 by using full war emergency power and up to 1/2 flaps on most airplanes. See the aircraft's checklist for details.

The climb is a carefully executed process

The rate of climb for piston aircraft is normally greatest at sea level and falls steadily as the aircraft gains altitude. The weight of the aircraft, the power setting, and the climbing speed are absolutely critical in obtaining proper and accurate climb performance and if any of these parameters change, the time and distance to climb will also change. For most aircraft, there are two climb power settings: rated power and desired climbing power. The lower power setting is usually reserved for lower aircraft weights and in some cases the higher power settings are not desirable due to fuel economy or engine cooling reasons. It can easily be seen that a simple figure published in a book cannot begin to accurately indicate an aircraft's actual ability to climb.

An engine can run out of breath

Engines, like people, need air to breathe. The higher the altitude, the thinner the air. The solution is supercharging or turbocharging, which is basically a fan in the induction system that forces more air into the engine when needed, so it can get the air it needs to breathe.

Superchargers are geared directly to the engine crankshaft, moving as one with the engine. Higher RPM = Higher boost. Turbochargers do essentially the same thing as superchargers with the primary difference being the turbocharger is powered by exhaust air pressure and not by internal, direct gearing.

The critical altitude, for supercharged or turbocharged aircraft, is the altitude at which maximum power can no longer be maintained. For example, if your maximum power is achieved at 50" manifold pressure, then the altitude at which you can no longer achieve 50" manifold pressure is called your critical altitude.

Flaps improve slow flight characteristics

It is common that simulated aircraft are built with drastically exaggerated flap drag values, including the stock aircraft. Therefore, many virtual pilots habitually fly the landing approach far too high and have a much greater rate of descent than is actually specified for a particular aircraft. These very high flap drag values allow pilots to get away with unrealistically steep, high approaches. This is not the case with Wings of Power aircraft.

This can easily be demonstrated by setting the aircraft up on a simulated final approach at a specified landing weight. Thrust, drag and weight are in the proper equilibrium as specified. The same is true for all Wings of Power aircraft, which can be tested in the same way. The bottom line is that flaps are not air brakes; these aircraft need to be flown at the proper speeds and power settings or landings are going to be very challenging!

To obtain ultimate realism, fly the Wings of Power aircraft by the numbers using the information given in each aircraft's checklist. Even better, go out and buy a copy of the aircraft's actual flight manual and use that to fly the plane. That's what we did.

Mustang – A short history

In April, 1940, when World War II was, for Britain at least, in a kind of holding pattern and waiting to burst forth into the savage fury that would soon engulf the entire world, the British Air Purchasing Commission (BAPC) requested that North American Aviation, Inc. (NAA) build 300 Curtiss P-40s for the R.A.F. Had "Dutch" Kindelberger, NAA's President agreed to this, what is generally considered to be the greatest piston engine fighter aeroplane ever built would have never been created.

Instead, NAA counter offered that they could produce a superior aeroplane to the P-40 and agreed to do it in 120 days. 102 days later the first Mustang airframe was completed, and 47 days after that the first Mustang flew. It went on to serve in every theatre of the War and in every Allied air force. A total of 16,766 were built, making it the most numerous American fighter aircraft.

Because of the great care and attention to aerodynamic detail that went into its brilliant design, the Mustang was, from its inception, one of the fastest single-engine piston aeroplanes of the W.W. II era. The Mustang was originally conceived in large part as a low altitude fighter-bomber; and, accordingly its Allison V-1719-39, 1120 h.p., liquid cooled engine with its single stage supercharger, capable of producing full power only up to 11,300' was initially sufficient. However, as the War quickly progressed, tactical requirements for higher altitude fighters greatly increased.

It was not, however, until the Curtiss P-40F was fitted with a Packard built V-1650 Rolls-Royce Merlin engine with its two-stage supercharger in late 1941, which greatly raised its formerly insufficient critical altitude that NAA and Rolls-Royce engineers got the idea of doing the same for the P-51. On 30 November, 1942 the first Packard-built V-1650-3 Merlin powered XP-51B Mustang flew; and after that the already very fast P-51 came into its own, the B model attaining a true airspeed of 439 m.p.h. at 25, 000'. This capability, along with its large internal fuel capacity of 269 U.S. gallons in the two wing tanks and one fuselage tank aft of the pilot's seat, plus the Mustang's ability to carry a total of 419 gallons (B/C models) and 489 gallons (D/K models) with drop tanks, gave it the extraordinary range of 1,900 miles (B/C models) and 2,055 miles (D/K models) respectively.

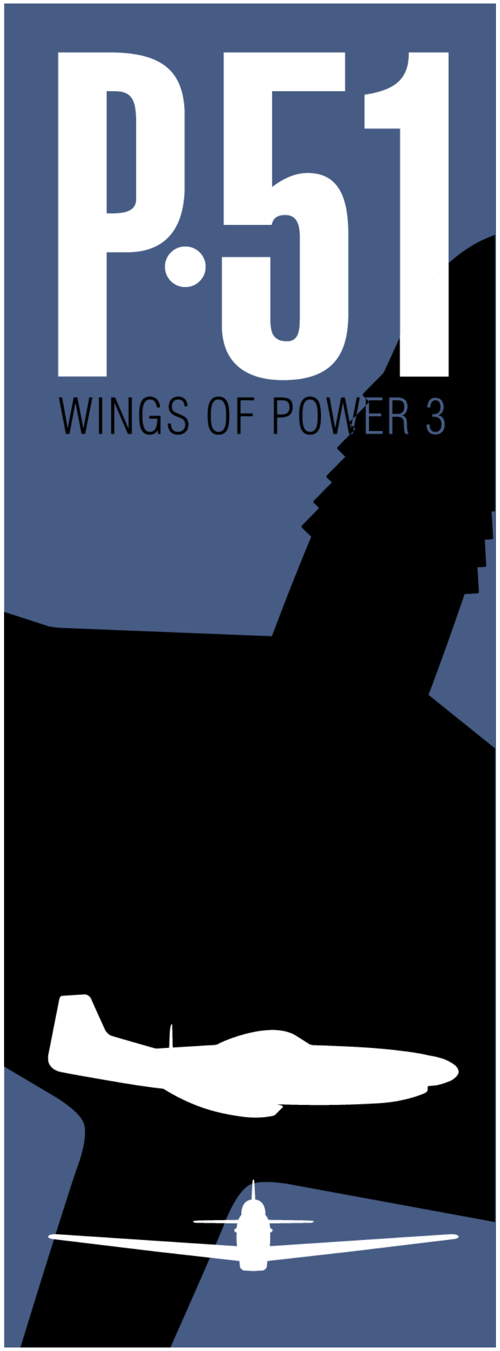
Unlike previous USAAF escort fighters, P-47 and P-38, the P-51 could escort bombers from their bases in England, deep into Germany, and back home again. Better still, once the P-51s engaged Luftwaffe interceptors, they were fully capable of dogfighting with, and destroying them. Then, usually with plenty of fuel remaining, they were specifically assigned to go on ground-attack hunts, destroying aircraft, locomotives and other strategic military targets before returning home. It was said that the Mustang could do for eight hours what the Spitfire could do for only two.

In 1943 the terrible and unacceptable attrition rate of the largely unescorted USAAF bombers over Europe, culminated in the Schweinfurt/Regensburg missions of August 17, 1943 (of 376 B-17s, 60 were lost and as many as 95 heavily damaged) and again at Schweinfurt on October 14, 1943 (of 291 B-17s, 77 were lost and 121 heavily damaged). This caused the USAAF to curtail deep penetration daylight bombing for five months and almost ended the daylight bombing program for good. It was the advent of the Mustang with its ability to stay with the bombers all the way and back again which saved this crucial program from cancellation. Once the Mustang was there to protect the bombers, the Luftwaffe was never again able to inflict such terrible losses. The Mustang's positive effect on the successful outcome of the War and upon human history itself is, accordingly, tremendous and incalculable.

Because they were so needed in the European Theatre, the P-51 came late to the Pacific. The first groups of P-51As were based in India in May, 1944 and were used mostly for the ground attack missions for which they were originally designed. Whilst more and more P-51s trickled to the Pacific with the winding down of air combat in European skies, it was not until the capture of the airfields on Iwo Jima on 26 March, 1945 that large groups of P-51s began to escort the B-29s in earnest. To no one's surprise, the P-51 was particularly suited to Pacific Theatre operations due to its extreme range. While it could not out-turn or dogfight with most of the Japanese fighters (no other Allied fighter could, either), the Mustang's speed and firepower soon made wreckage of those fighters which they opposed.

Giving good service at the opening of the Korean Conflict until relieved by the nascent jet- powered fighters of those days, the venerable Mustang has since then had a spectacular career as a racing and airshow aeroplane which is surely destined to continue well into the future.

Reckoned by many to be the best single-engine piston fighter of all time, the Mustang in all of its incarnations is indeed, as it has been called, "The Cadillac of the Skies".



2 Quick Start Guide

Chances are, if you are reading this manual, you have properly installed the A2A Wings of Power P-51 Mustang. 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 P-51 Mustang 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
- Windows 10

PROCESSOR:

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

HARD DRIVE:

- 250MB of hard drive space or better

VIDEO CARD:

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

OTHER:

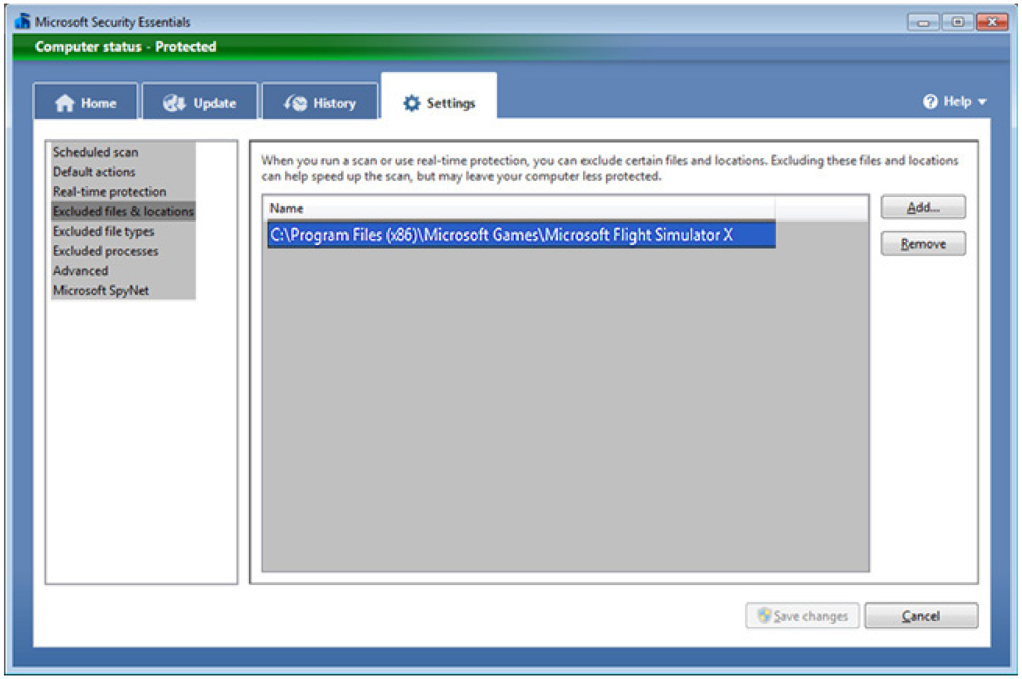
- DirectX 9 hardware compatibility and audio card with speakers and/or headphones

Installation

Included in your downloaded zipped (.zip) file, which you should have been given a link to download after purchase, is an executable (.exe) file which, when accessed, contains the automatic installer for the software.
To install, double click on the executable and follow the steps provided in the installer software. Once complete, you will be prompted that installation is finished.

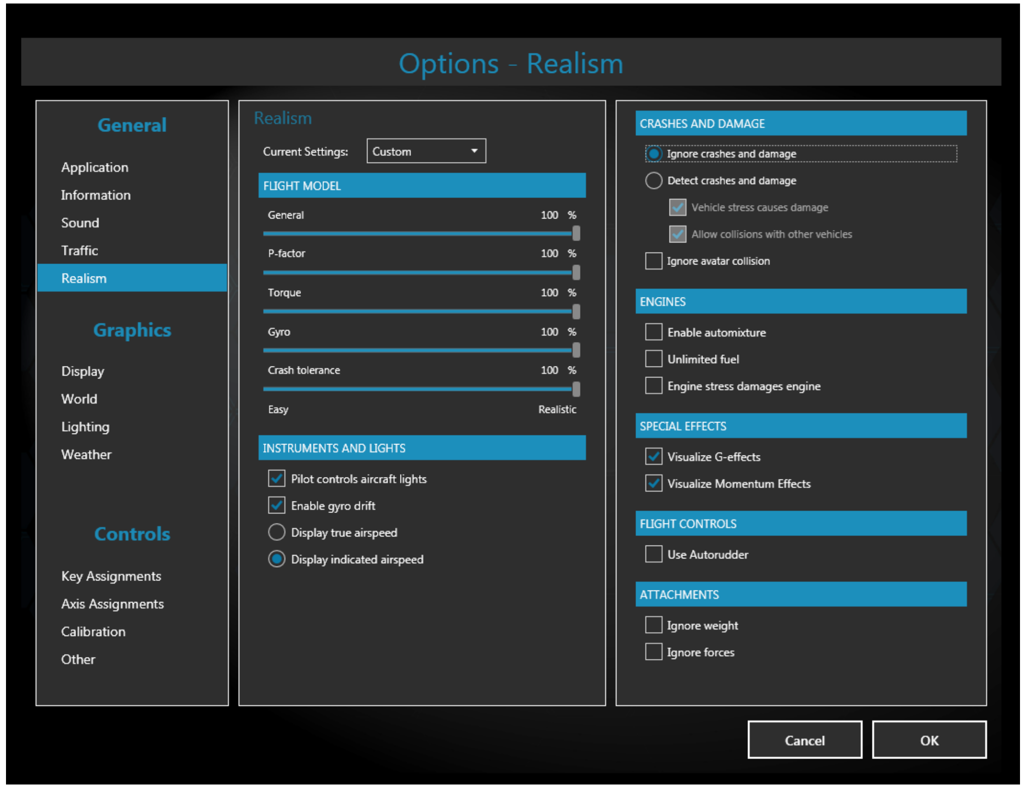
Importan

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



The A2A Simulations P-51 Mustang 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 P-51 Mustang.



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 below.

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 automixture" is NOT checked.

Flight Controls

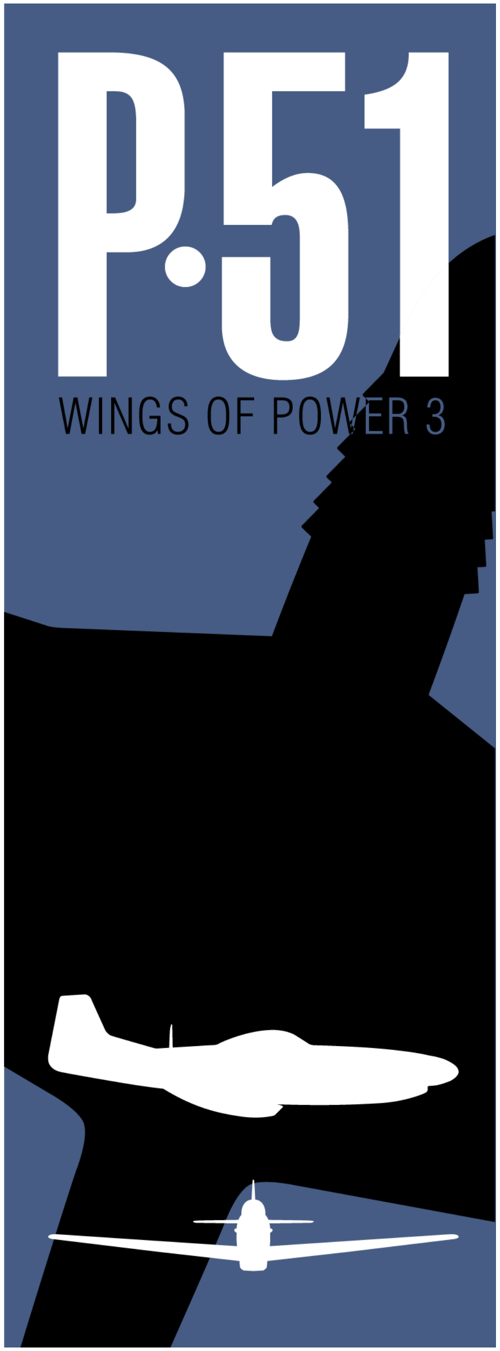
It is recommended you have "Auto-rudder" turned off if you have a means of controlling the rudder input, either via side swivel/twist on your specific joystick or rudder pedals.

Engine Stress Damages Engine

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

Quick Flying Tips

- To Change Views Press A or SHIFT + A.
- Click and hold the electric primer to use.
- In hot weather, get airborne fast. Plan your flight, start your engine, do a quick run-up, and get off the ground.
- 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. (Accu-sim required)
- REDUCE POWER after takeoff. This is standard procedure with high performance aircraft.
- The aircraft does not have AUTO-RICH or AUTO-LEAN mixture, but rather a single RUN setting.
- DO NOT lower gear when going over 170mph IAS.
- On landing, if coming in too fast, raise your flaps once you touch down to settle the aircraft, pull back on the stick for additional elevator braking while you use your wheel brakes.
- Be careful with high-speed dives, as you can lose control of your aircraft if you exceed the max allowable speed.
- For landings, take the time to line up and plan your approach. Don't use the landing gear or flaps as brakes. Keep your eye on the speed at all times.
- Using a Simulation Rate higher than 4X may cause odd system behavior.
- Keep throttle above 1/3 when flying at high RPM to avoid fouling plugs. (Accu-sim required)
- A quick way to warm your engines is to re-load your aircraft while running.
- The Mustang's maneuvering speed is 270mph indicated. Above this speed, hard maneuvers can over-stress the airframe. Below this speed, hard maneuvers can induce an accelerated stall.



3 P-51 Mustang Variants

P-51D-25 44-72854, 457th FS/506 FG, ‘KWITCHERBITCHIN’

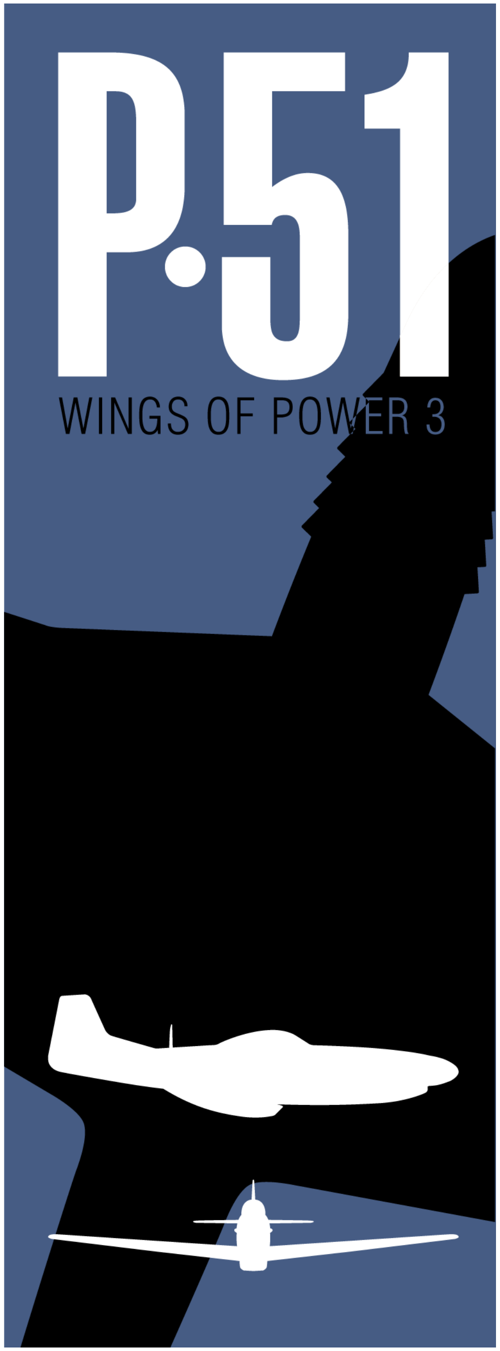
Flown by Captains William B Lawrence Jr and Alan J Kinvig. Based at Airfield No 3, Iwo Jima, Summer 1945. The victory flag is Captain Lawrence’s, representing the unidentified single engined aircraft he shot down on the 16th July 1945. The blank victory flag probably represents the Ki-44 Tojo he damaged on the 10th June 1945.

P-51D-25 44-73304, 'Blondie'

Flown by Lt. Marvin Arthur of the 334th Fighter Squadron, 1945. QP-U 44-73304 was assigned to Lt. Marvin Arthur and he had a picture of his wife painted on the nose. 'Blondie' and Lt Marvin Arthur scored 1.5 kills before the end of hostilities in Europe.

F-51D 44-73064

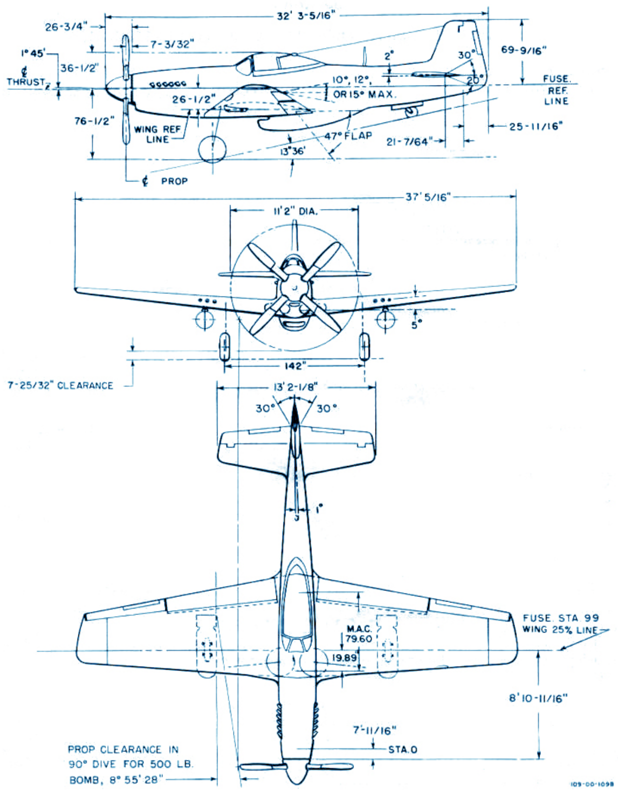
Flown by Lt. Jake Armstrong of the 67th Fighter Bomber Squadron, Korea, 1952.



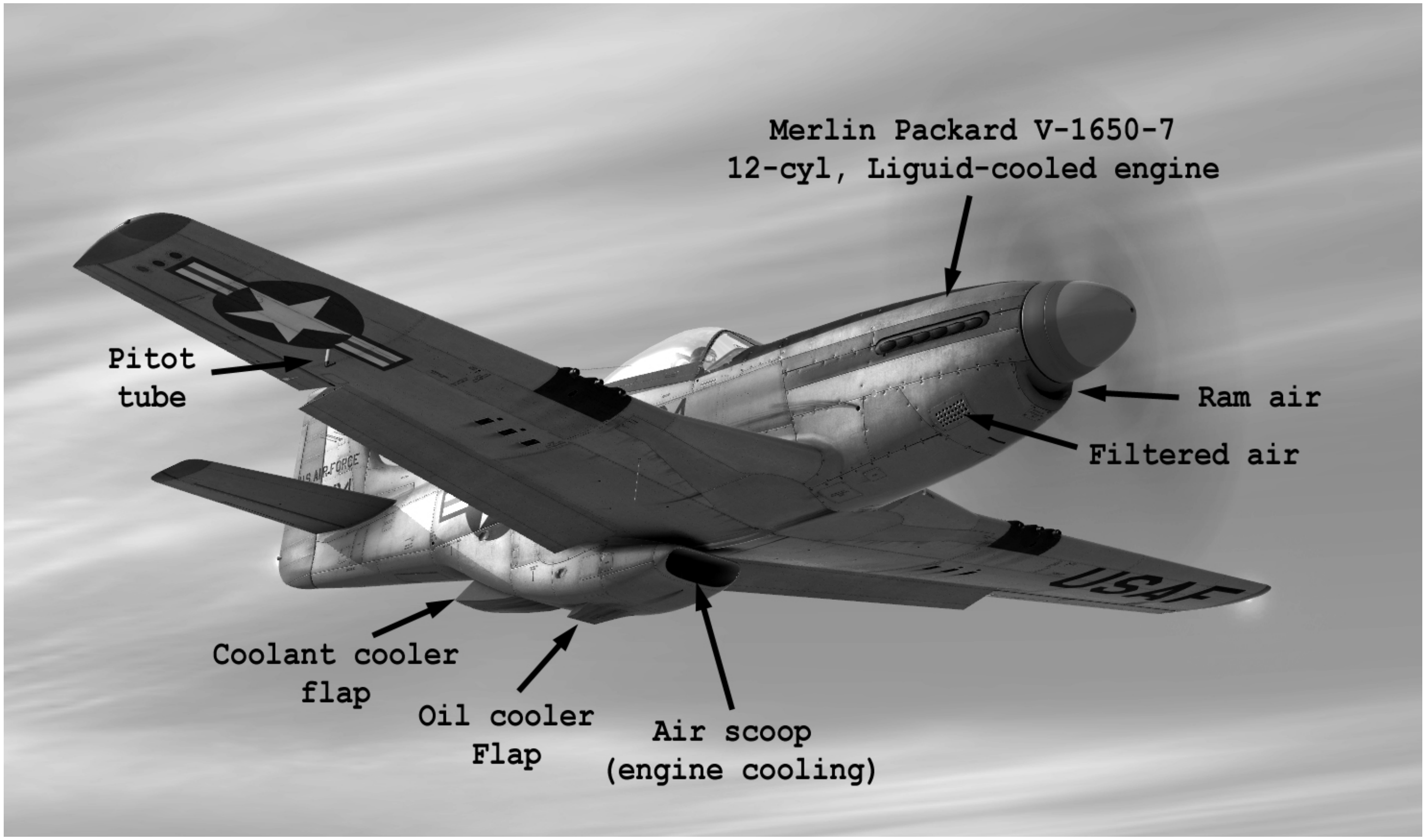
Model P-51D Mustang Specifications

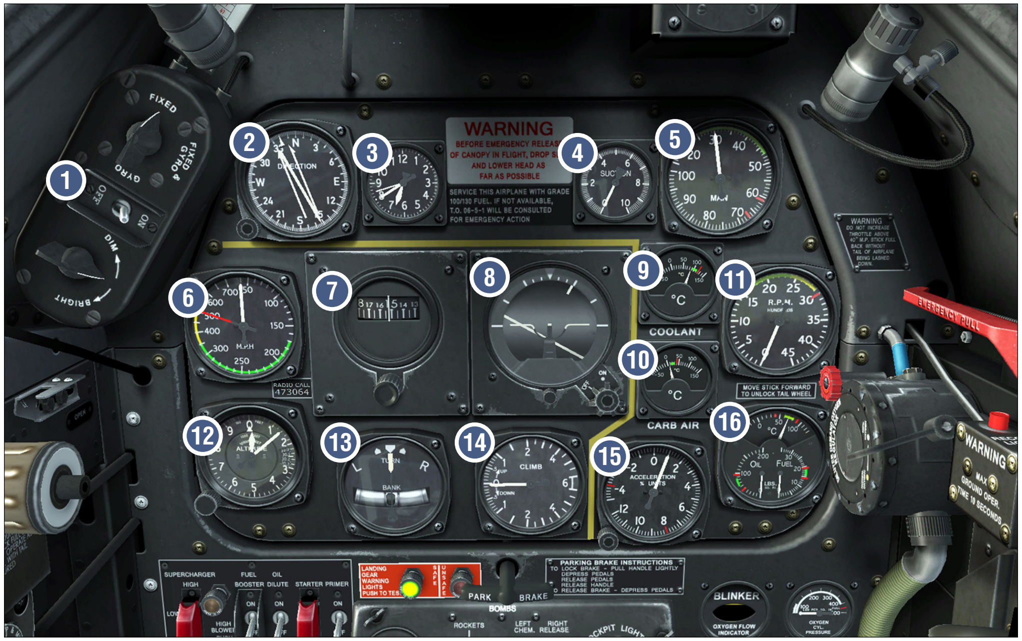
Wing Span	37 feet, 5/16 inches
Length	32 feet, 3 5/16 inches
Height	12 feet, 2 2/5 inches
Powerplant	1,700 hp Rolls Royce Packard Merlin 12-cyl, V-1650-7 liquid-cooled engine
Weights	7,635 lbs empty weight
Service Ceiling	41,900 feet
Top Speed	437 mph @ 25,000 feet
Climb	7.3 min to 20,000 feet
Fuel	269 gal (485 gal total with drop tanks)
Takeoff Run	367 yards
Combat Range	395 miles

4 Specifications

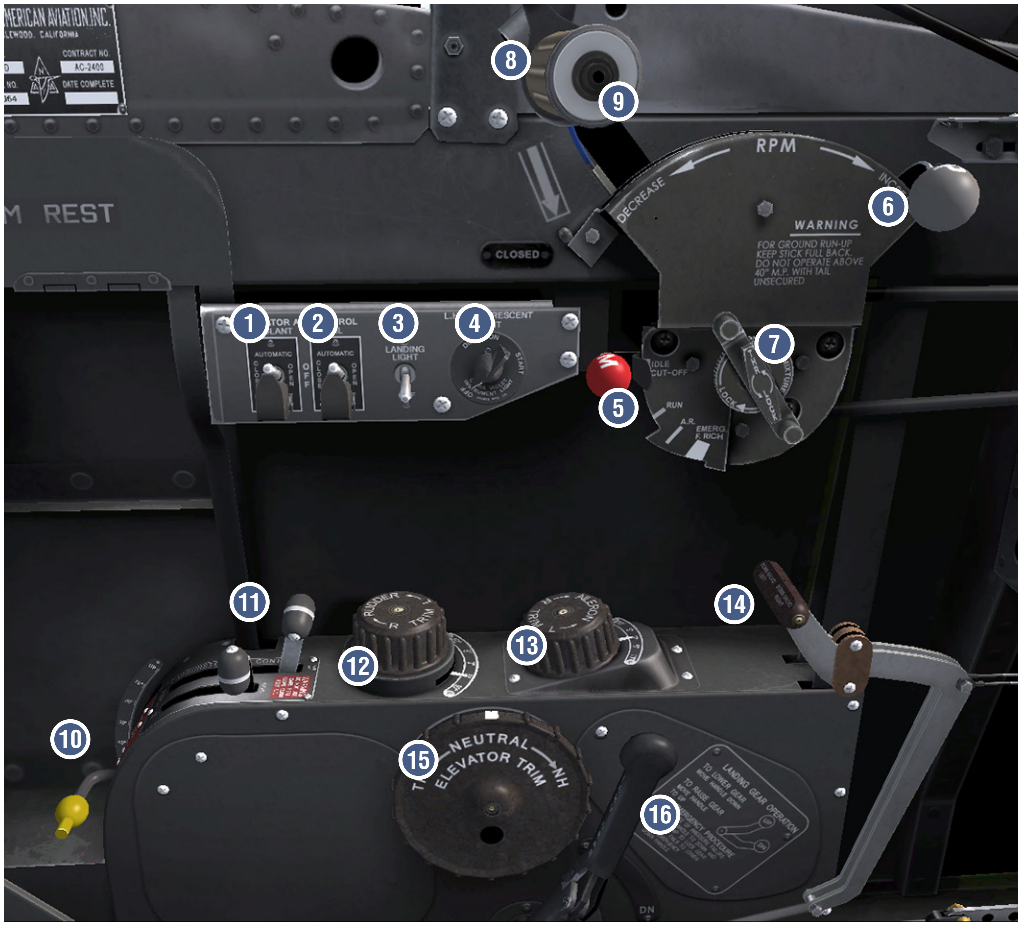


Airframe External

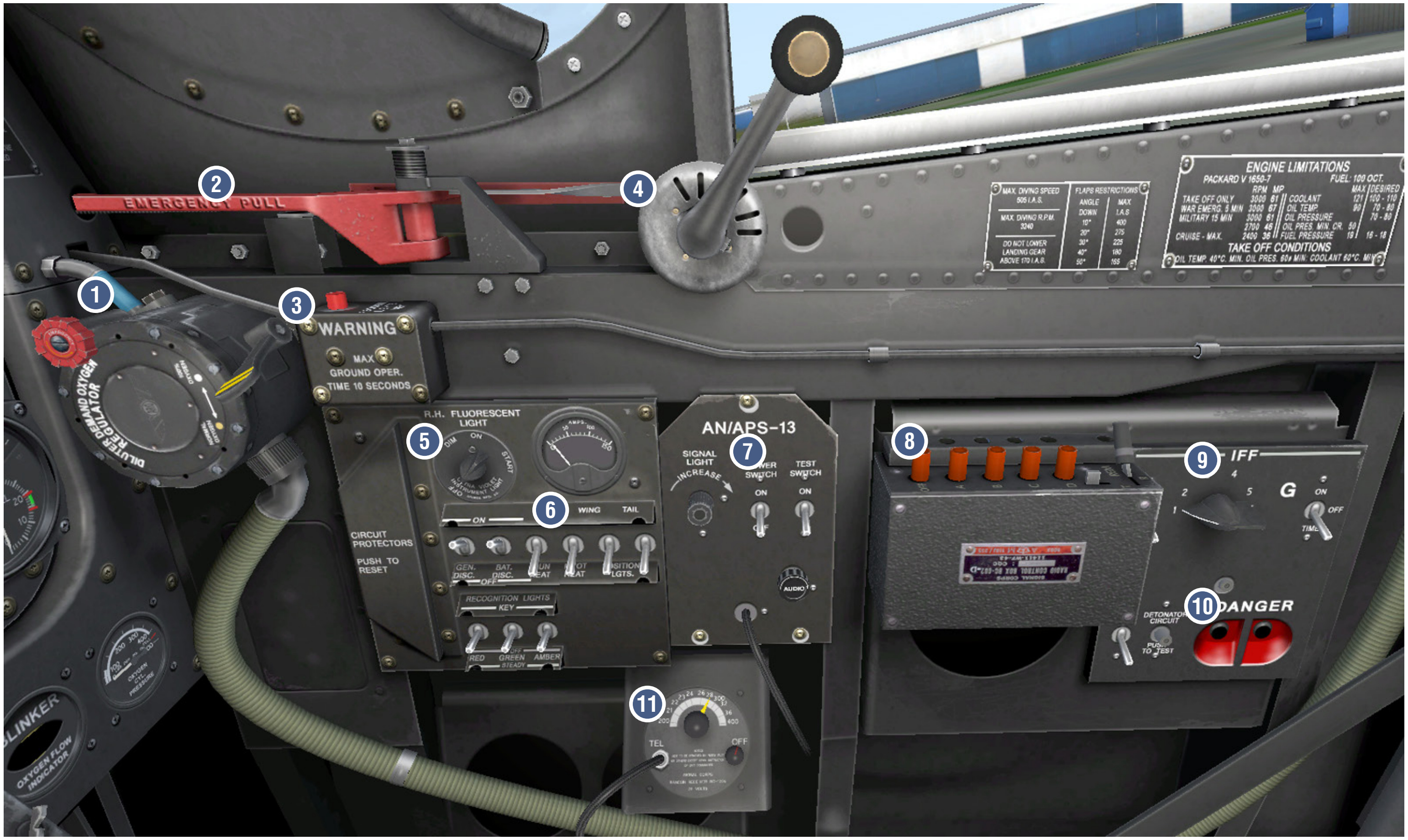




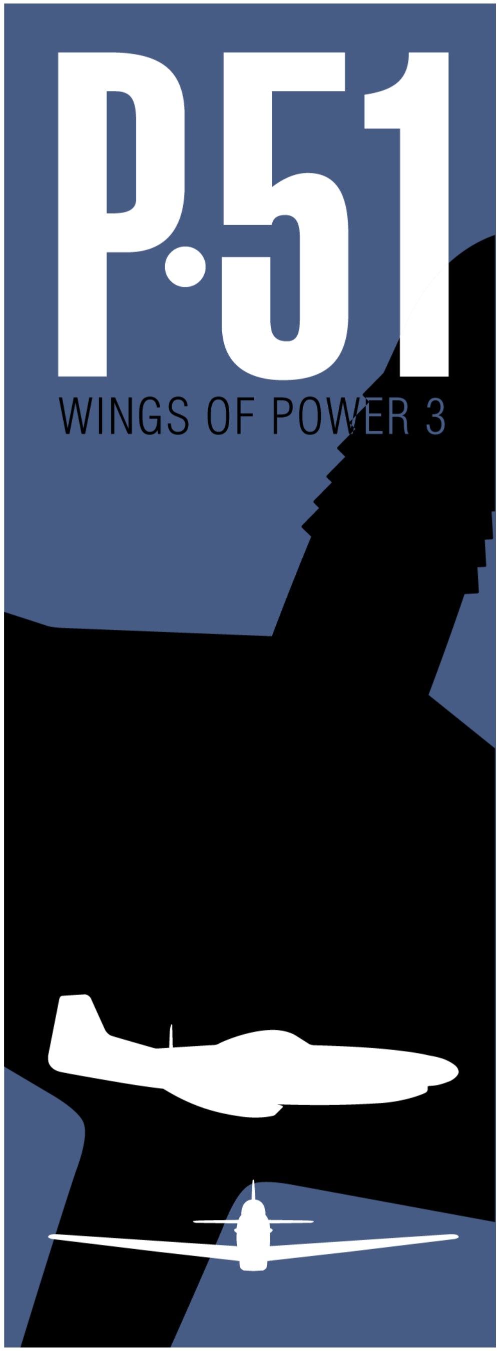
1. Selector Dimmer Controls
2. Remote Indicator Compass
3. Clock
4. Suction Gauge
5. Manifold Pressure Gauge
6. Airspeed Indicator
7. Directional Gyro
8. Artificial Horizon
9. Carburetor Air Temperature
10. Coolant Temperature
11. Tachometer
12. Altimeter
13. Bank-and-Turn Indicator
14. Rate-of-Climb Indicator
15. Acceleration
16. Oil Temperature, Fuel and Oil Pressure Gauge
17. Engine Control Panel
18. Landing Gear Warning Lights
19. Parking Brake
20. Oxygen Flow Blinker
21. Oxygen Pressure Gauge
22. Ignition Switch
23. Fuel Shut-off Valve
24. Fuel Selector Valve
25. Emergency Hydraulic Release



1. Coolant Radiator Air Control Switch
2. Oil Radiator Air Control Switch
3. Landing Light Switch
4. Left Fluorescent light Switch
5. Mixture Control
6. Propeller Control
7. Throttle Quadrant Locks
8. Throttle
9. Microphone Button
10. Flap Control Handle
11. Carburetor Air Controls
12. Rudder Trim Tab Control
13. Aileron Trim Tab Control
14. Bomb Salvo Releases
15. Elevator Trim Tab Control
16. Landing Gear Control



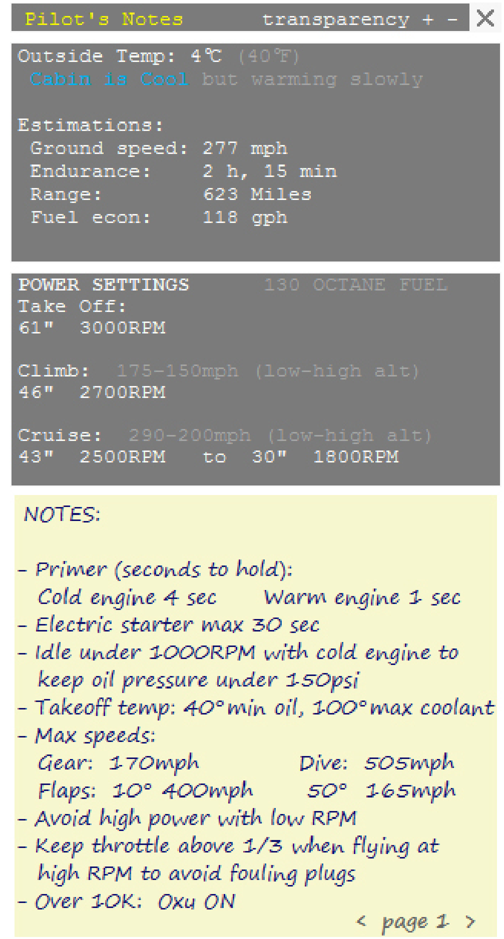
1. Oxygen Regulator
2. Emergency Canopy Release
3. Recognition Light Key
4. Canopy Crank and Lock
5. Right Fluorescent Light Switch
6. Electrical Control Panel
7. Rear Warning Radar Control Panel
8. Radio
9. IFF Control Panel
10. Detonator Buttons
11. Detrola Control Box



PILOT'S NOTES (SHIFT-2)

Important information is readily available with the Pilot's Notes screen.

- **Outside Temp** is the temperature of the air outside
- **Cabin Temperature** is shown below in terms of how the cabin temperature feels
- **Ground Speed** is the actual speed your aircraft is moving over the ground surface.
- **Endurance** is the amount of time your aircraft can fly at the current rate of fuel consumption. Take into account, as you are climbing to your cruise altitude, this estimated endurance will be less than once you level off, throttle back, and settle into a cruise.
- **Range** is the distance your aircraft will fly at the current speed and rate of fuel consumption. Again, take into account this will change based on climb, cruise, and descent operations.
- **Fuel Economy** is the current rate of fuel consumption in gallons per hour (gph).
- **High Temp Warning** will display if your engine temperatures get close to maximum allowed. This becomes vital information if you install the Accu-Sim P-51 Mustang Expansion Pack as high temperatures can damage your engine.
- **Power Settings** represent your clipboard showing you important info to quickly establish a proper takeoff, climb, and cruise.



- **Notes** appear below along with abbreviated checklists for takeoffs, landings, etc. Click the arrows at the bottom to browse through the available pages.

CONTROLS (SHIFT-3)

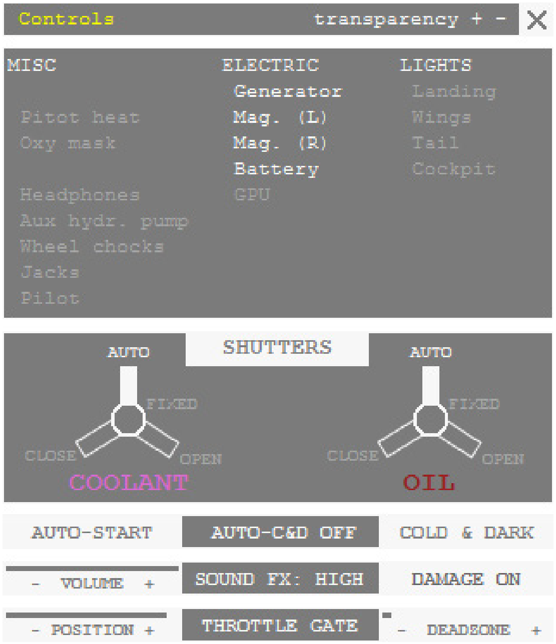
This control panel was initially created to allow you to operate and watch systems like lights and engine flaps while in the external view. It soon became a nice little place where we could put anything we wanted to have quick access to.

You can:

- Attach your GPU (ground power unit) for easier startups
- Put on your oxygen mask
- Set wheel chocks
- Jack up the aircraft
- Remove the pilot
- Adjust various switches and levers including your radiator flap, lights, etc.
- Set the aircraft to a cold-start state
- Set aircraft to automatically start in a cold start state
- Set throttle gate to match your joystick detent

Additionally, Accu-Sim users can:

- Enable or disable damage modeling
- Adjust the volume of the Accu-Sim sound system
- Use headphones

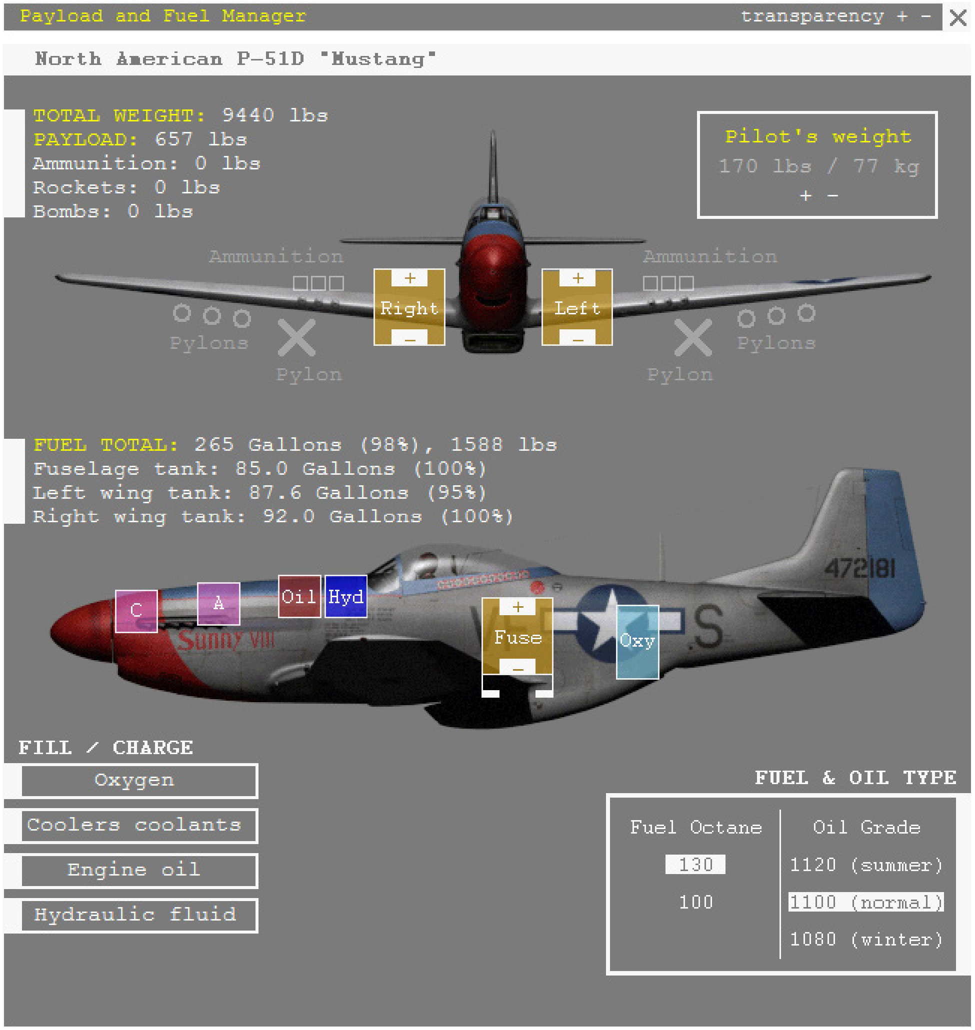


PAYLOAD AND FUEL MANAGER (SHIFT-4)

This real-time payload and fuel manager allows you to visually click and load your aircraft. You can service:

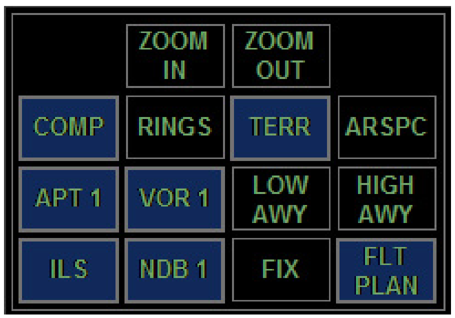
- Fuel
- Ammunition
- Oxygen
- Coolant fluid
- Engine oil
- Hydraulic fluid
- Aftercoolant fluid
- Remove fuselage tank
- Change fuel grade
- Change oil grade

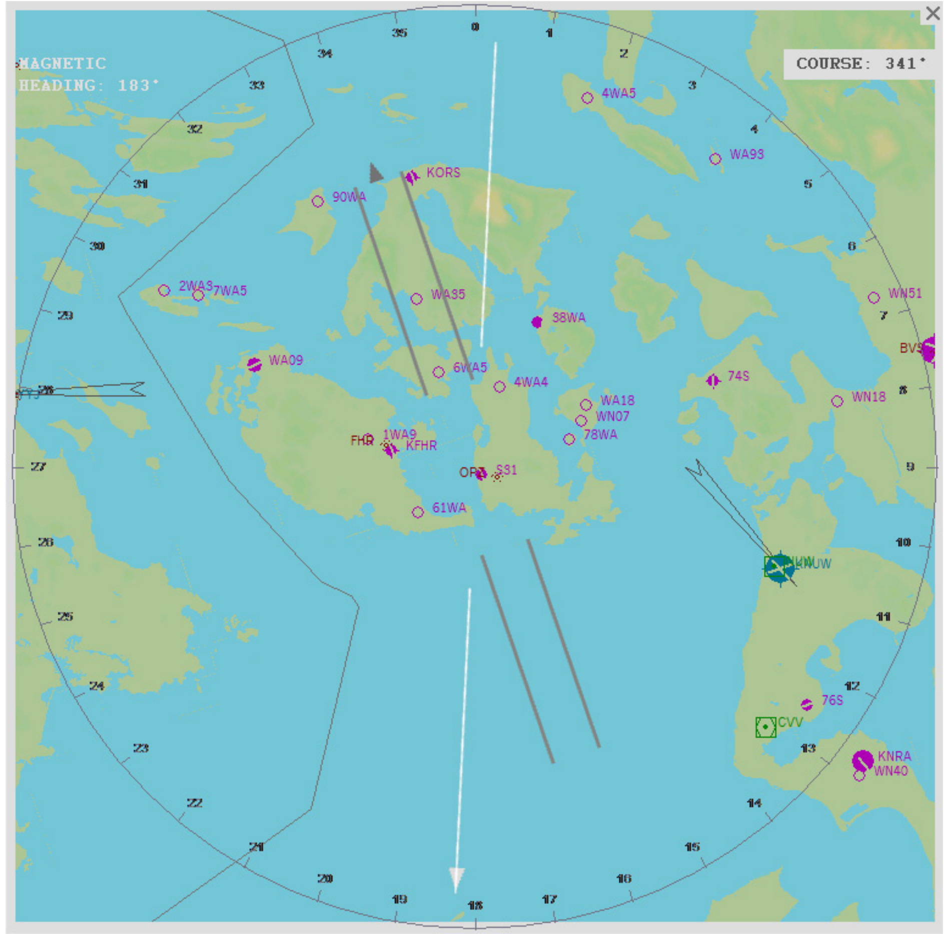
The aircraft initially is prepared for a standard flight with ammunition loaded.



PILOT'S MAP (SHIFT-5)

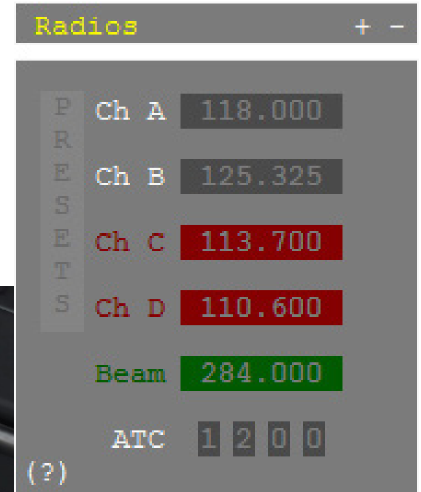
The pilot's map gives full access to similar information that may be found on real maps and allows this information to be easily accessed rather than have to use the default map from the upper menus. This is a period aircraft, so we tried to create this in the true light of a pilot needing to still use visualization or VOR to know precisely where the aircraft is over the map, hence, we did not include the little aircraft icon in the middle. You can access this map by clicking on the map box in the lower left area of the cockpit.





RADIO SELECTOR (SHIFT-6)

The 2D radio selector panel allows you to set the frequency of the radio. Moving the lever at the bottom of the cockpit radio also adjusts this frequency.



MAINTENANCE HANGAR (SHIFT-7)

Note: While the maintenance hangar is accessible for non-Accu-Sim installations, engine damage, wear, and advanced systems modeling is part of the Accu-Sim expansion pack.

The Maintenance Hangar is where you can get a review of how your aircraft engine and major systems are functioning.

You can both see and read your crew chief's report stating:

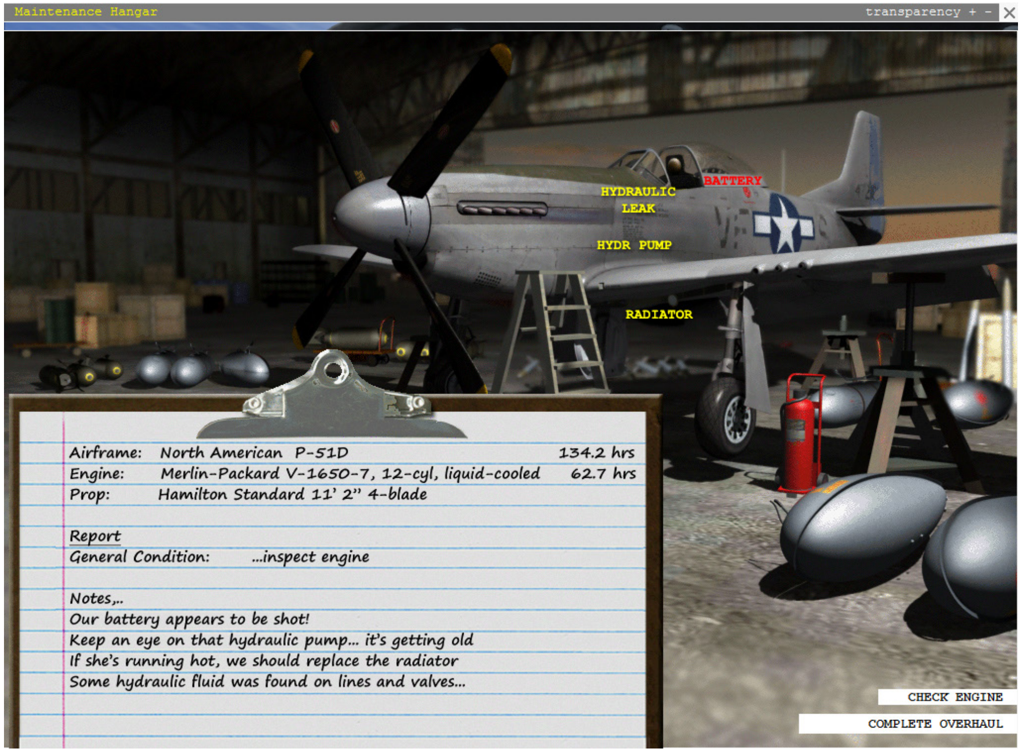
- A summary of your airframe, engine, and propeller installed
- Hours on airframe and engine since last major overhaul
- General condition of the engine
- Notes

You can also perform a COMPLETE OVERHAUL by clicking on the OVERHAUL button. This overhauls the engine and replaces any parts that show any wear with new or re-conditioned ones.

In the above example, your crew chief has reported some hydraulic leaks were found along with some moderate wear on your left brake. To repair each one, simply click on the yellow highlighted area over your aircraft.

You also notice your mechanic has mentioned that some engine accessories need repairs. To look further into the engine condition, click on the CHECK ENGINE on the lower left.

Clicking on the CHECK ENGINE button pulls up a detailed cutaway of your engine.

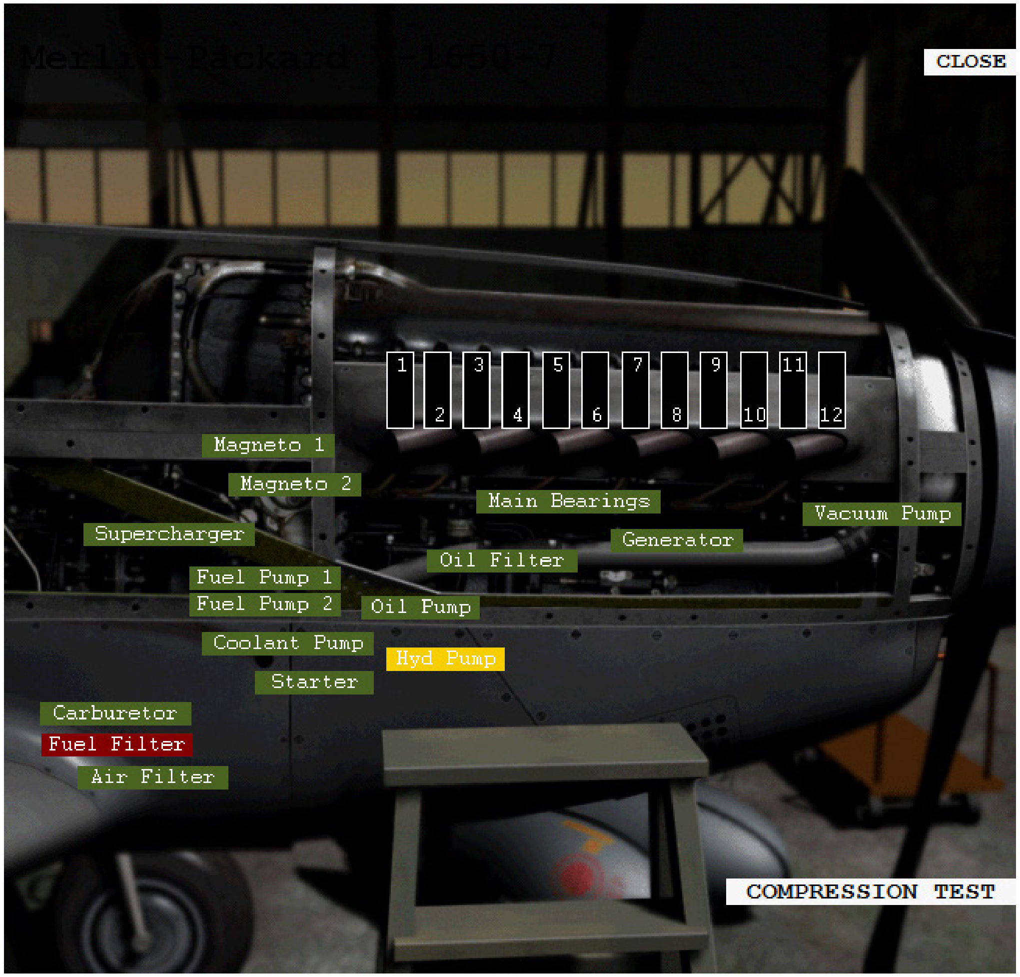


Color Codes

Green	OK
Yellow	Watch
Red	Must fix or replace

In the example here, our engine appears to be in pretty good shape with the exception of a worn hydraulic pump and clogged fuel filter. Your mechanic's inspection picked up this wear, and it is shown here. A yellow condition means it is recommended that you replace or repair this item, but it is not mandatory. You can choose to keep a close eye on this part and continue flying.

Heavy wear or failure would highlight the part in red.



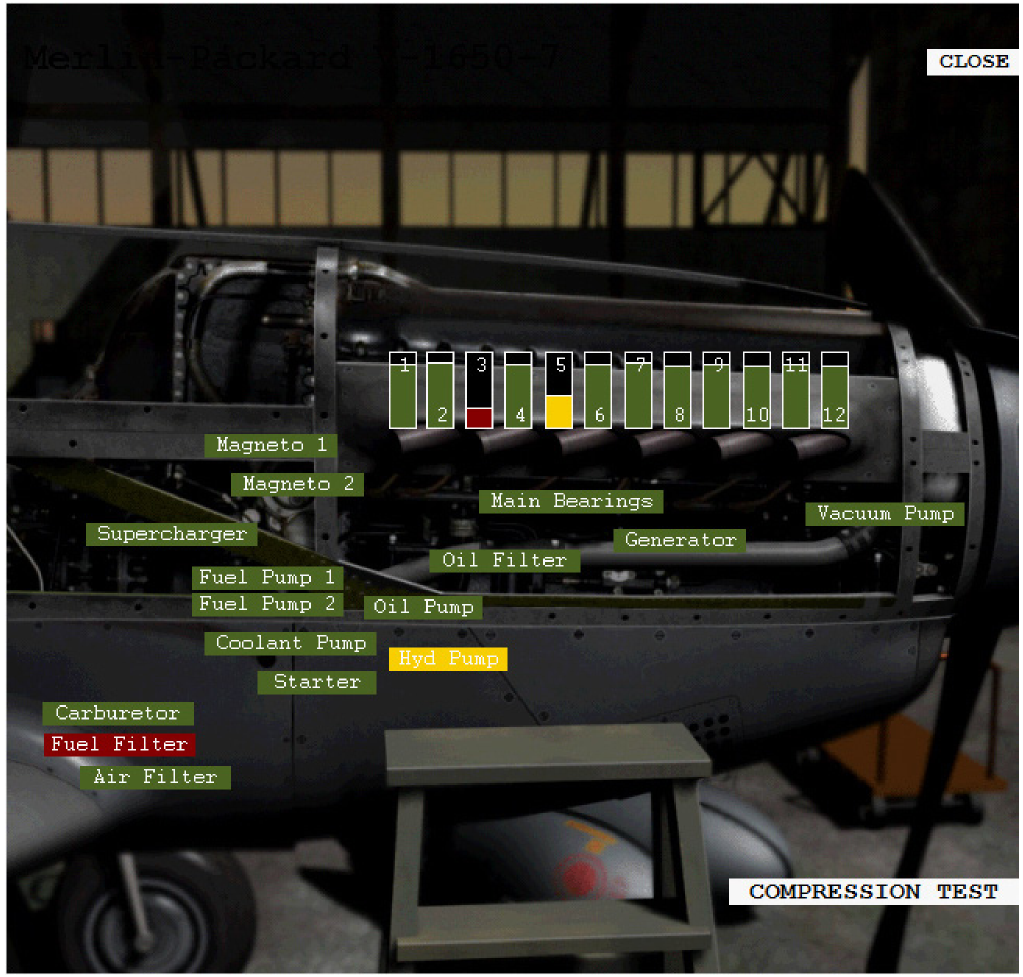
At the lower right is a "Compression Test" button, which tells your mechanic to run a high-pressure air test on the engine cylinders, checking for leaks past the cylinder rings. A civilian may choose to replace a cylinder that is only showing modest wear, perhaps in the 50-60psi range, whereas the military could allow a plane to fly with a cylinder as low as 30 psi.

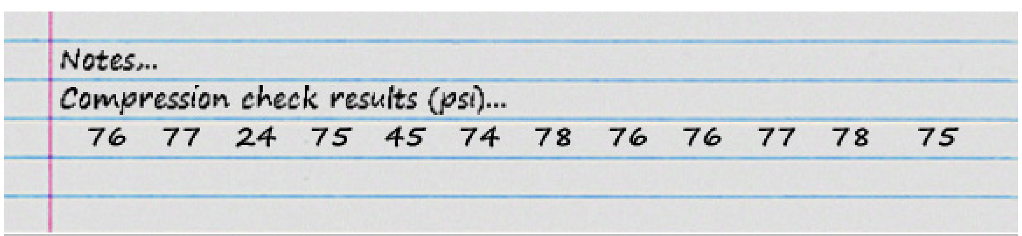
Low compression on a cylinder isn't necessarily a terrible thing, because as the engine picks up in speed, the worn cylinder becomes productive. It is mostly noticed at lower R.P.M.'s where the cylinder may have trouble firing, and also a marked increase in oil consumption may also occur (sometimes with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

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

Also note, after performing a compression test, your mechanic writes down the exact numbers in his notes.

The engine pictured here has a completely failed #3 cylinder and poor #5 cylinder. #5 will fire with higher RPM, but #3 may never fire properly.





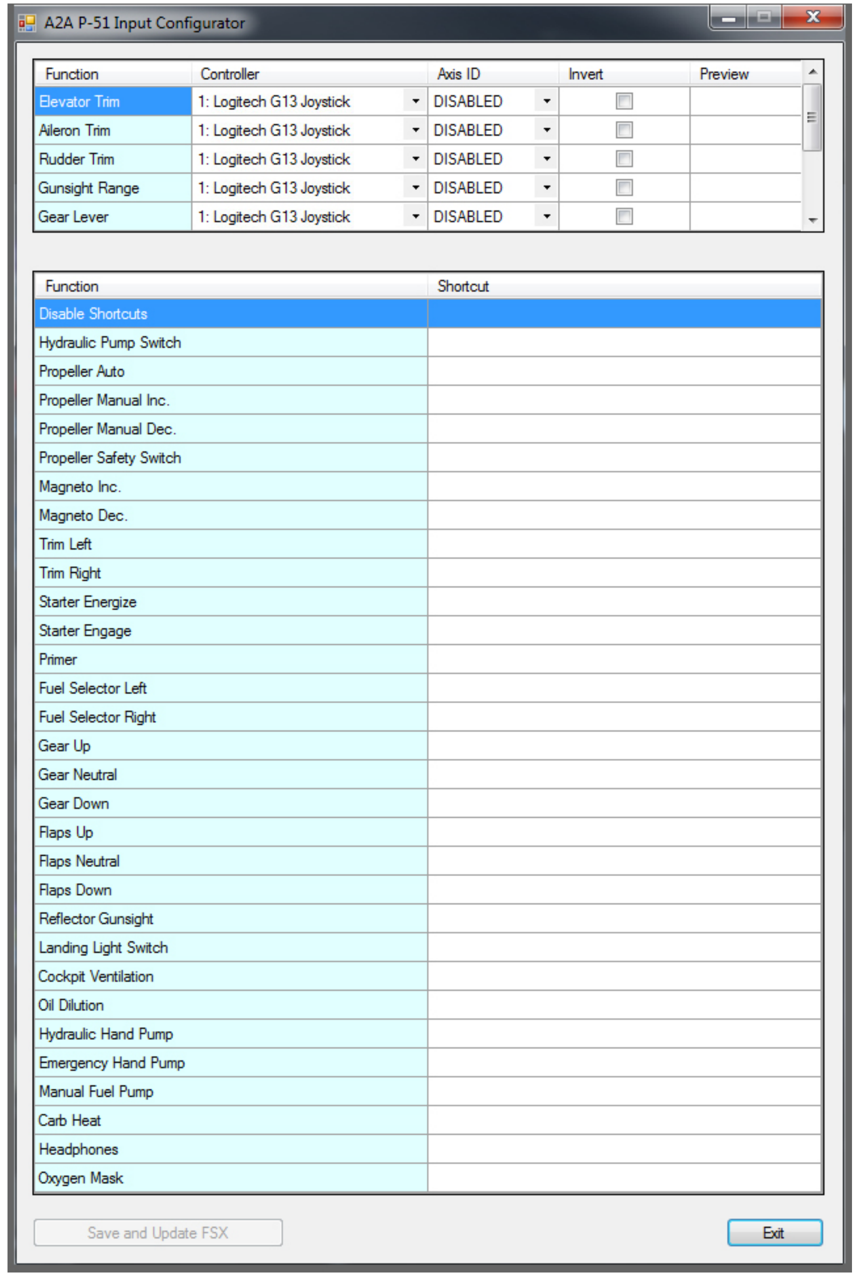
Joystick Mapping Utility

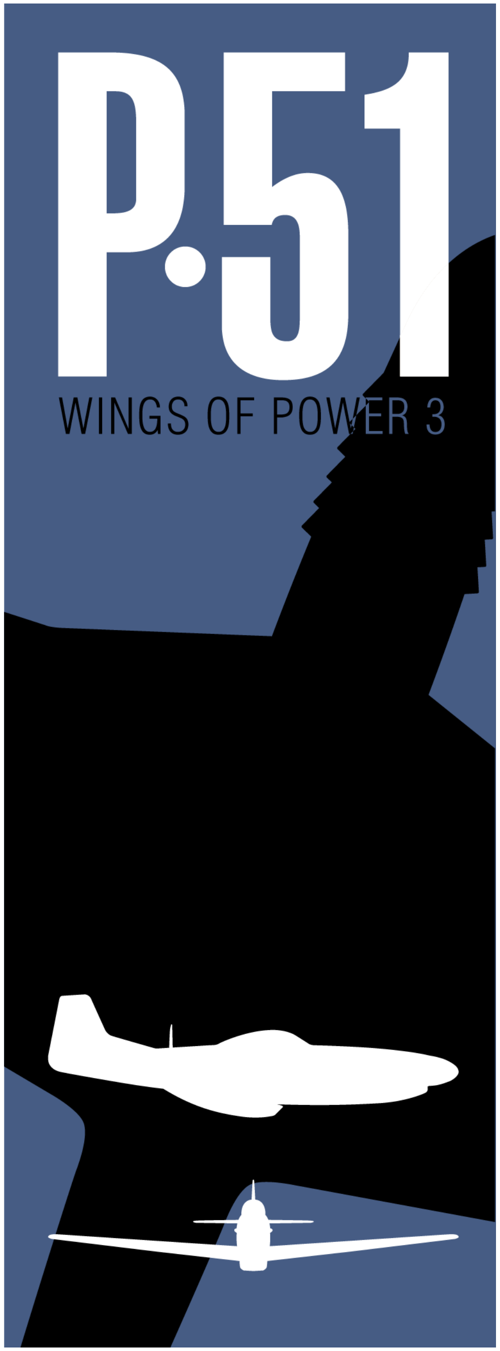
The Input Configurator is a small utility that allows users to assign keyboard or joystick mappings to many custom functions that can't be found in P3D controls assignments menu. It can be found in the A2A/P-51/Tools folder inside your P3D installation directory.

The upper table is the axis assignment menu. From the drop down list, select joystick and axis you want to assign to each function and verify its operation in the 'preview' column. Mark the 'invert' check box if needed.

The lower table is the shortcuts menu. Hover over 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).

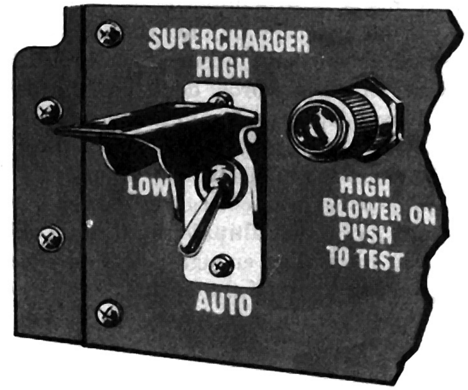
When done with the assignments, press "Save and update P3D" button. This will instantly update shortcuts for the Mustang. There is no need to restart P3D or even reset flight for the changes to take effect, you can adjust shortcuts on the fly.





6 Systems

Supercharger



The engine has a two-speed, two-stage supercharger which cuts into high blower automatically. The -3 engine cuts in at 19,000 feet, the -7 engine at from 14,500 to 19,500 feet, depending on the amount of ram air. The supercharger increases the blower-to-engine ratio from a low of about 6 to 1 to a high of about 8 to l.

You can also control the supercharger manually by a switch on the instrument panel. The switch has three positions-AUTOMATIC, LOW and HIGH.

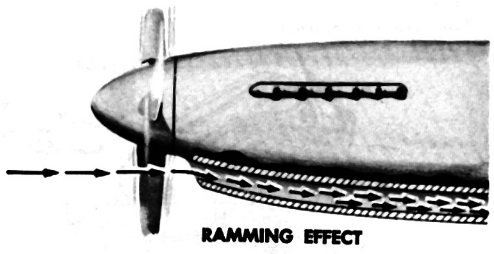
For all normal operations, keep the switch in AUTOMATIC. In this position the supercharger is controlled by an aneroid-type pressure switch, which automatically cuts the unit into high or low blower as required. This switch is so adjusted that it cuts the unit back into low blower approximately 1500 feet under the altitude at which it cuts into high blower. This prevents the high blower from going on and off repeatedly with slight changes in altitude at about the point where the high blower cuts in.

If the aneroid switch fails, the supercharger automatically returns to low blower.

The LOW position on the manual switch on the instrument panel makes it possible to operate the supercharger in low blower at high altitudes. This gives you better range at high altitudes- which, of course, is important on long range flights.

The HIGH position on the manual switch makes it possible to test the high blower on the ground or to use High Blower in case of an aneroid failure if necessary.

An amber jewel indicator light next to the manual switch on the instrument panel goes on when the supercharger is in high blower.



Carburetor

The engine has an injection-type carburetor and an automatic manifold pressure regulator. With this automatic regulator, you don't have to jockey the throttle to maintain a constant manifold pressure in the high-speed range as you climb or let down. All you have to do is select the desired pressure by setting the throttle lever, and the pressure regulator does the rest. It compensates automatically for the difference in air density at different altitudes by gradually opening the carburetor butterfly valve as you climb and smoothly closing it as you decend.

On later airplanes, the automatic regulator covers practically your entire operating range, going into action whenever you use more than 20" of manifold pressure. Airplanes equipped with this type of regulator can be distinguished by the START position plate on the throttle quadrant. In earlier airplanes the manifold pressure regulator is effective only at pressures in excess of 41".

Carburetor air comes through a long carburetor air scoop directly under the engine. The plane's motion forces the air at high speed (or rams it) directly into the carburetor. This is called ram air.

If the scoop becomes obstructed by ice or foreign matter, a door in the air duct opens automatically to admit hot air from the engine compartment to the carburetor.

Ordinarily you will always use ram air, but, in the event of extreme icing or dust conditions, the carburetor air controls on the left cockpit pedestal allow you to select either un-rammed filtered or, in later airplanes, un-rammed hot air for operation. In order to obtain hot air, the hot air control must be at HOT and the cold air control at UNRAMMED FILTERED AIR. If the cold air control is in RAM AIR position, the hot air control will be ineffective.

Don't use hot air above 12,000 feet. At high altitudes its use will disturb the carburetor's altitude compensation, and may cause too lean a mixture.

War Emergency Power

In order to give your engine an extra burst of power should you get into an extremely tight situation, move the throttle full forward past the gate stop by the quadrant, breaking the safety wire. The engine will then be opened up to its absolute limit, and will give you about 6" of manifold pressure in excess of the normal full throttle setting of 61" (with mixture control at RUN and prop set for 3000 rpm).

This throttle reserve is called war emergency power, and should be used only in extreme situations. If you use it for more than 5 minutes at a time you'll risk damaging vital parts of the engine. In training, therefore, the throttle must never be moved beyond the gate stop.

Whenever you do use war emergency power, you should report the time to the crew chief or engineering officer so that a record can be kept and the engine inspected before the airplane is flown again. The engine must be removed for a complete knock-down inspection after 5 hours.

Note: We record this time in the maintenance hangar.

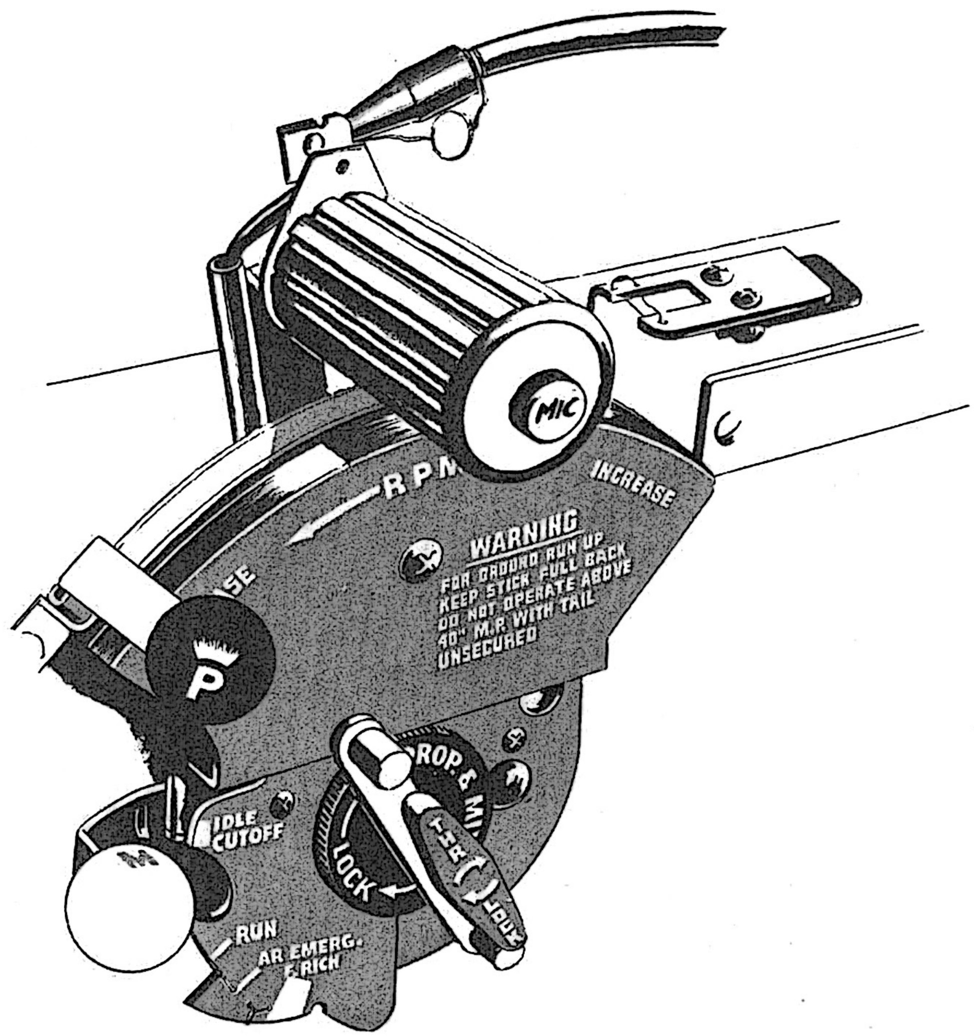
Throttle Quadrant

Late model Mustangs are equipped with a single-position carburetor. The mixture control has the following settings: IDLE CUT-OFF, RUN, and EMERGENCY FULL RICH. These carburetors are fully automatic and the normal operating position is RUN. The EMERGENCY FULL RICH position is for use in case the carburetor fails to function properly in RUN.

The quadrants have two friction-lock adjusting knobs. One adjusts the friction of the propeller and mixture control levers, the other the throttle control lever.

Propeller

The P-51D propeller is a Hamilton Standard, four-blade, hydraulic, constant-speed prop with a diameter of 11 feet 2 inches and a blade angle range of 42°. As is the case with all single engine aircraft, the prop cannot be feathered. You control propeller rpm manually by a single lever on the throttle quadrant.



Landing Gear

The main gear and tailwheel are fully retractable, and are controlled hydraulically by a single lever on the left pedestal. Do not raise the control lever when the airplane is on the ground. There is no safety downlock on a P-51D, and the gear will retract as soon as you start taxiing.

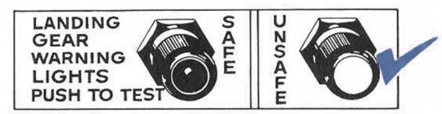
The tailwheel is both steerable and full swiveling. It is steerable 6° right or left with the rudder. The tailwheel lock is different from that of most other planes-it is operated by the control stick. When the stick is in neutral position or pulled back, the tailwheel is locked and steerable. When you push the stick full forward, the tailwheel is unlocked and full swiveling.

The tailwheel drops almost instantly when you push the landing gear lever to the DOWN position. The main gear takes 10 to 15 seconds to move into position. You can definitely feel the gear lock into place when it is lowered.

You can release the landing gear in an emergency by means of a red handle just above the hydraulic pressure gauge. Pulling this red handle releases the pressure in the hydraulic lines. This allows the gear to drop of its own weight when the landing gear lever is in the DOWN position. The landing gear lever must be in the DOWN position-all the way down-or the mechanical locks which hold the gear in place are not unlocked.

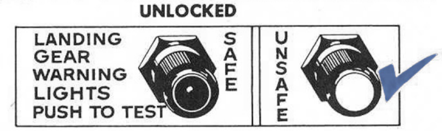
Note that the red handle releases the pressure in the hydraulic lines. Therefore, if you want to operate the flaps or the fairing doors after you have dropped the gear by means of the red handle, you must push the handle back to its original position. If you leave it out-all or even part way out-you won't have any hydraulic pressure to operate the flaps.

If the gear is not down and locked when you come in for a landing, you'll be warned by a combination of red and green warning lights below the instrument panel and a horn aft of the seat. The horn sounds only when the landing gear is up and locked, while the throttle is retarded below the minimum cruise condition, and may be silenced by the cut-out switch on the front switch panel. This switch automatically resets when the throttle is advanced.



Horn Blowing

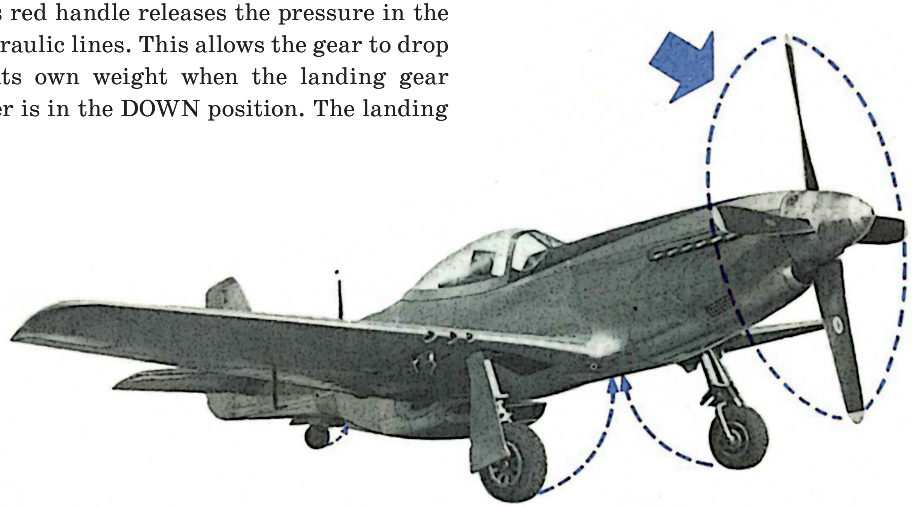
THROTTLE . . . RETARDED
DOORS . . . . CLOSED
GEAR. . . . . UP AND LOCKED OR DOWN AND UNLOCKED



THROTTLE . . . ANY POSITION
DOORS . . . . OPEN
GEAR. . . . . DOWN AND UNLOCKED OR UP AND LOCKED

THROTTLE . . . ANY POSITION
DOORS . . . . ANY POSITION
GEAR. . . . . DOWN AND LOCKED

THROTTLE . . . ADVANCED
DOORS . . . . CLOSED
GEAR. . . . . UP AND LOCKED



Brakes

The brakes are hydraulic, of the disc type. The usual toe action on the rudder pedals controls each brake individually.

Hydraulic System

The hydraulic system is extremely simple and almost foolproof in its operation. It has two separate parts. One part of the system operates under pressure from a pump which is driven directly off the engine. This part operates the landing gear and the wing flaps. This "power" part of the system operates at a pressure of 1000 pounds per square inch (psi) while the engine is running.

The second part of the system works the brakes only. It is operated by the foot pressure of the pilot. The only connection between the two parts of the system is that they both receive their supply of fluid from the same tank. However, the tank is so designed that even if all the hydraulic fluid from the power part of the system is lost, there still is enough fluid to operate the brakes. So even if you lose the hydraulic pressure in your landing gear and flaps, you still can operate your brakes.

The parking brake handle is just below the center of the instrument panel. You operate the parking brakes in the conventional manner:

- Hold the brakes;
- Pull the parking brake handle out;
- Release the pressure on the brake;
- Then release the parking brake handle.

To release the parking brakes, simply push down on the foot pedals.

Electrical System

The electrical system is a 24-volt, direct-current system which provides power for operating the booster pumps, starter, radios, guns, the various electric lights, the bomb racks, and the coolant and oil radiator controls.

The electrical system runs off the battery until the engine reaches 1500-1700 rpm, when the generator is cut in by the voltage regulator. Power for the electrical system then is supplied by the generator. To prevent any damage to the electrical system from overload, circuit breakers are used. These eliminate the use of fuses and allow you to re-set broken circuits while still in flight.

The circuit breaker re-set buttons are on the right switch panel. On late models all the buttons can be re-set at once by means of one bar plate across the switches. All you have to do is simply bump this plate to restore the circuits.

An ammeter is on the same panel as the circuit breaker switches. This ammeter shows you how much current is flowing from the generator and also shows whether or not the generator has cut in at 1500-1700 rpm as it should.

The battery is just behind the pilot's armor plate in the radio compartment. The battery and generator disconnect switches are on the panel with the circuit breaker switches.

The lights of the electrical system include cockpit and gunsight lights, one powerful sealed-beam landing light in the left wheel well, recognition lights, and standard navigation lights on the wingtips and on the rudder.

Except for the booster coil, which is used only in starting, the ignition system is completely independent of the electrical system, and will continue to function normally in case of electrical system failure. Ignition power is supplied by the magnetos; the switch is on the front switch panel.

Fuel System

The Mustang has two main fuel tanks, one in each wing. They are self-sealing, and have a capacity of 92 gallons each. An auxiliary 85-gallon self-sealing tank is installed in the fuselage, aft of the cockpit. There is also provision for carrying two droppable combat tanks on the bomb racks. These are available in 75-gallon and 110-gallon sizes; normally you'll use only drop tanks of 75-gallon capacity, since the extra weight of the larger tanks imposes near-limit loads on the wings and bomb racks. Droppable tanks are not self-sealing. Making them so would add unnecessary weight, for it has been found that shot-up external tanks will not remain afire when the airplane is in flight.

Total fuel capacity of the airplane, with 110- gallon droppable tanks, is 489 gallons.

To cruise the Mustang scientifically, plan your flight in accordance with the Flight Operation Instruction Charts included at the end of this manual.

Fuel is forced to the carburetor by an engine driven pump at a normal operating pressure of 16-19 psi. In addition, there is an electrically powered booster pump in each internal tank.

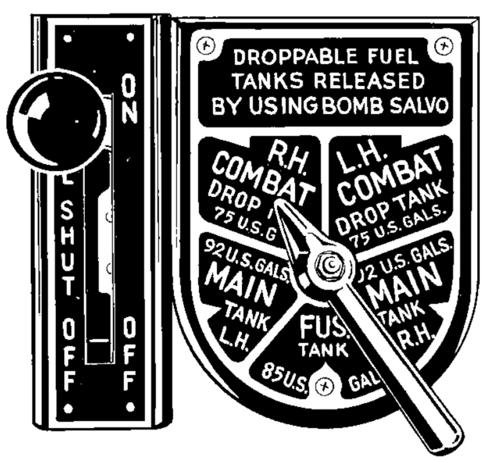
In case of engine driven pump failure, the booster pumps will provide enough fuel to the carburetor for normal engine operation.

The fuel selector control is on the floor of the cockpit, just in front of the stick. As you rotate the valve handle you'll notice a definite snap as each tank position is reached. Be sure you feel this snap. It's your guarantee that the valve is properly set.

The electric primer installed on later airplanes is controlled by a momentary toggle switch next to the starter switch. Earlier series planes have a hand primer on the right side of the instrument panel. One second's operation of the electric primer is about equivalent to one stroke of the hand primer.

Caution: When changing tanks, don't stop the selector valve at an empty tank position, or at a droppable tank position if you have no droppable tank. If you should accidentally do this, or if you run a tank completely dry, your engine will fail, and you must act immediately as follows:

- Turn the fuel selector to a full tank;
- Make sure that the booster pump switch is ON;
- As your engine takes hold, adjust the throttle setting as required.



Oil System

The oil system includes a tank, located just forward of the firewall, and a radiator in the air scoop under the fuselage.

The tank is a hopper type- that is, it is designed with hoppers or compartments which facilitate quick warm-up and also make it possible to fly the airplane in abnormal positions, with little oil in the system.

With this tank you can fly the P -51 in any altitude when the tank is full. Or you can put it into a vertical climb or dive when the tank is only ¼ full and still get proper lubrication.

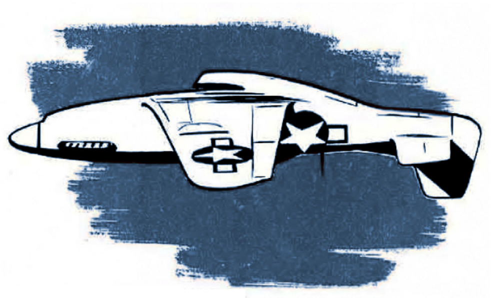
However, when the plane is in inverted flight, the oil pressure falls off because no oil reaches the scavenger pump. For that reason you must limit inverted flying to 10 seconds-which is plenty of time for any normal or combat maneuvers.

An outlet door on the bottom of the air scoop controls the oil temperature. Under ordinary circumstances this door operates automatically.

However, if you want to operate it manually when you're running your engine on the ground, for example, or in case the automatic regulator fails in the air- you can do so by means of an electrical switch on the left side of the cockpit.

This switch has three positions: AUTOMATIC, OPEN, and CLOSE. You can stop the door at any position by holding the toggle switch in the OPEN or CLOSE position for the necessary length of time, then returning the switch to neutral.

The oil system has standard AAF oil dilution equipment. This allows you to thin the oil with gasoline to make the engine easier to start in temperatures below 40 ˚F.



INVERTED FIYING LIMITED TO 10 SECONDS

Operation of the oil dilution equipment is simple. Allow the engine to idle, coolant flaps open, until the oil temperature drops to 50 ˚C or less. Then, before stopping the engine, use the dilution switch on the pilot's switch panel.

This dilutes the oil until you are ready to start the engine again. Once the engine warms up, the gasoline in the oil is quickly evaporated.

If the engine temperature is high, stop the engine and allow it to cool to an oil temperature of about 40˚C. Then start it again, and immediately dilute the oil as explained above.

Two minutes of oil dilution is sufficient for any temperature down to 10˚F. When starting in temperatures lower than that, heat is sometimes applied to the engine and oil system. Therefore, no fixed oil dilution time can be given in this manual; you'll be specially instructed in accordance with local operating conditions.

Total capacity of the oil system is 21 gallons.

Cooling System

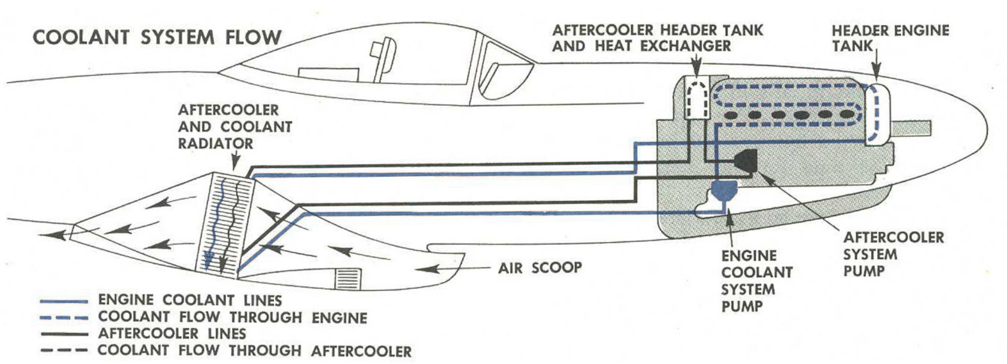
With the radiators located in the big airscoop aft of the cockpit under the fuselage, the cooling cools the engine proper.

The engine coolant system is a high-pressure system (30 psi) and its capacity is 16 1/2 gallons.

The coolant used is a mixture of ethylene glycol and water.

An air outlet door at the rear of the air scoop controls the temperature of the coolant. This door operates similarly to that of the oil cooler.

Normally, it works automatically, but you can control it manually by means of a switch on the left side of the cockpit, next to the oil cooler door control switch. Both switches are on the radiator air control panel.



The Canopy

The cockpit enclosure is of the half-teardrop type; it consists of an armor glass windshield and a sliding canopy formed from a single piece of transparent plastic. The canopy is designed to give you the best possible vision in all directions, since obstructions above, at the sides, and to the rear have been eliminated.

You get into the cockpit from the left side. To help you up on the wing, there is a handhold in the left side of the fuselage. You can step on the fairing in getting up on the wing, but be careful that you don't step on the flaps.

To open the canopy from the outside, push in on the spring-loaded button at the right forward side of the canopy, and slide the canopy aft.

You control the canopy from within by means of a hand crank. Depressing the latch control on the crank handle unlocks the canopy, after which you can turn the crank to slide the canopy open or closed. Releasing the latch control locks the canopy in any position.

To warn you against taking off without having the canopy properly secured to the airplane, there are two red indicator pins, one at each side of the canopy. If these pins are visible the canopy isn't properly locked.

Never take off if you can see the pins. If you do, your canopy will blow off.

The emergency release for the canopy is the long red handle on your right, above the oxygen controls. When you pull this handle, the entire canopy flies off. The handle is safetied with light safety wire.

Cockpit

The cockpits of fighter-type airplanes are generally pretty cramped, and that of the Mustang is no exception. Concentration of numerous instruments and controls into a small space is unavoidable. In the case of the P-51D, the controls are simplified, and their grouping has been planned to give you the greatest possible efficiency. As fighter airplanes go, the cockpit is comparatively comfortable.

The cockpit can be both heated and ventilated. Cold air is fed into the cockpit through a small scoop located between the fuselage and the big air scoop. Warm air is fed into the cockpit from inside the scoop just back of the radiator.

Warm air from this source also serves to defrost the windshield. The controls for regulating cold and warm air and the defroster are on the floor of the cockpit, around the seat, as shown in the accompanying illustration.

The pilot's seat is designed to accommodate either a seat-type or a back-pack parachute.

The back cushion is kapok-filled and can be used as a life preserver. The seat is adjustable vertically; you'll find the lock on your right. No fore-and-aft adjustment is possible.

Your comfort on long flights will be increased by a small, folding arm rest on the left side of the cockpit.

A standard safety belt and shoulder harness are provided. There is a lever on the left side of the seat for relaxing the tension on the shoulder harness. This permits you to lean forward whenever necessary-for example, to look out of the canopy in taxiing.

Oxygen System

The oxygen system in the P-51 is the same as that used in all modern army fighter planes.

It is a low-pressure demand-type system, that is you don't have to control the oxygen manually as you change altitudes. A regulator furnishes the right amount of oxygen required at any altitude. It does this automatically- all you have to do is inhale in your mask.

Controls and gauges for the oxygen system are in the right front section of the cockpit.

These include:

- the automatic mixture regulator,
- a pressure gauge, and
- a blinker indicator which indicates the flow of oxygen. The blinker opens when you inhale and closes when you exhale.

Notice in the illustration that there are two controls on the automatic mixture regulator.

The lever on the right turns the automatic mixing device on and off. For all normal operations it should be in the NORMAL OXYGEN position. Turn it to the 100% OXYGEN position if you want pure oxygen on demand. In this position the air intake is shut off and you breathe pure oxygen on demand at an altitude.

Emergency control.

By turning this knob to the open position you bypass the regulator and receive a continuous flow of pure oxygen. If the tanks are full, you get a flow of oxygen for about 8 minutes.

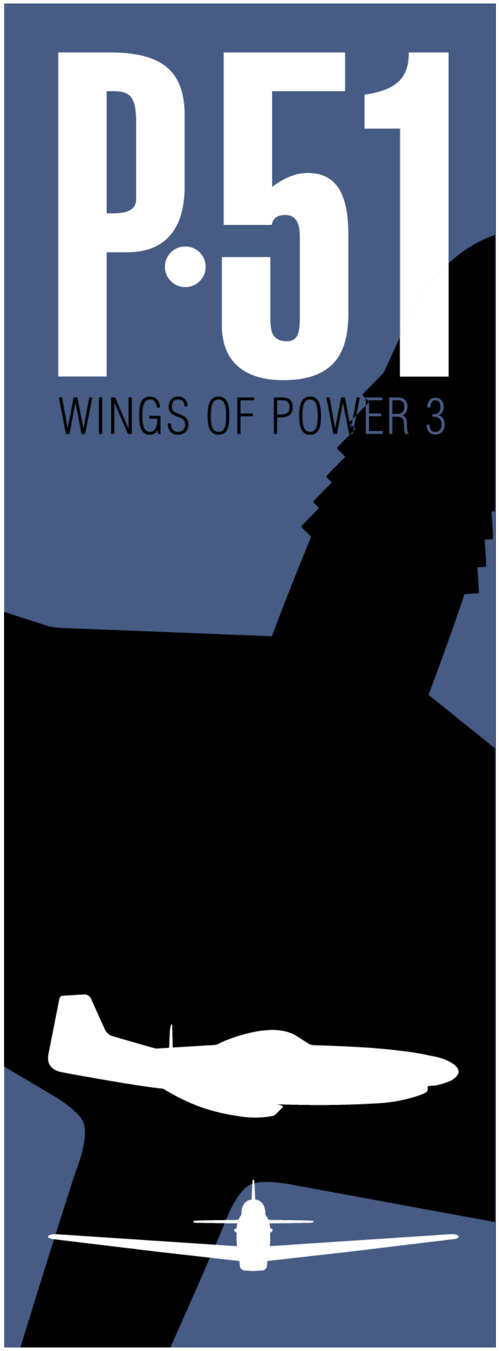
Your oxygen supply is carried in four tanks, which are installed just aft of the fuselage fuel tank. There are two D-2 and two F-2 tanks (which have twice the capacity of the D-2's), for a total volume of 3000 cubic inches. A filler valve, accessible through a small door in the left side of the fuselage, permits refilling the oxygen tanks without removing them from the airplane. Normal full pressure of the system is 400 psi.

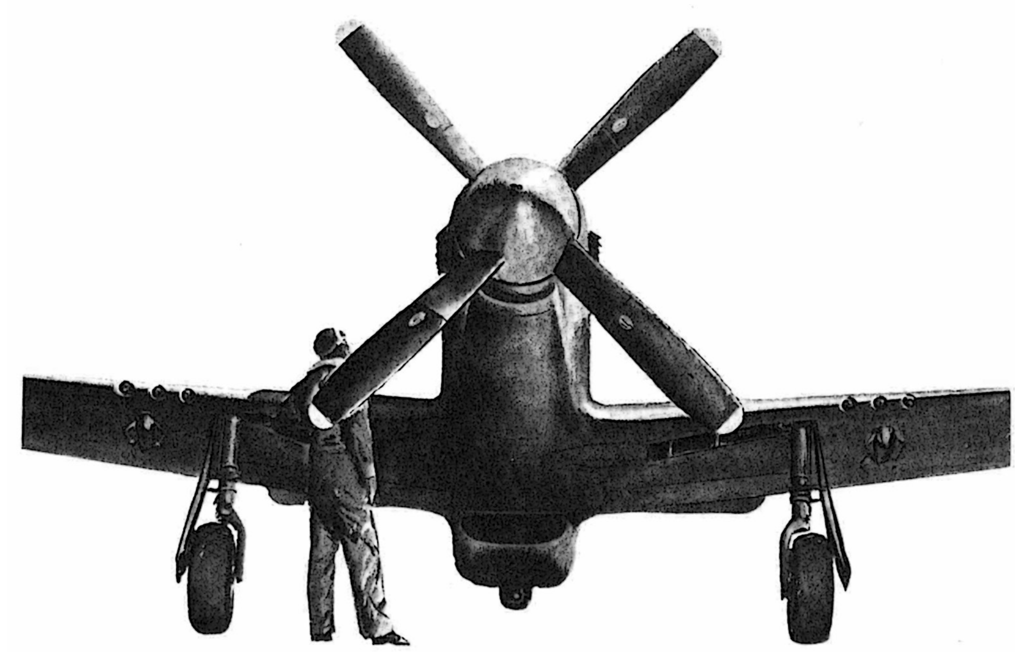
Recognition Lights

Three colored recognition lights (red, green, and amber) are located on the underside of the right wing, near the tip. By means of three position toggle switches on the electrical switch panel at your right, these lights can be used in any combination. You can burn them steadily, or flash code signals with them.

When these switches are in the down position, the lights burn steadily. When in the center position, they are off.

When in the up position, you can operate the light intermittently, in code signals, by means of the key on top of the small box just above the switches.





7 Flying the P-51

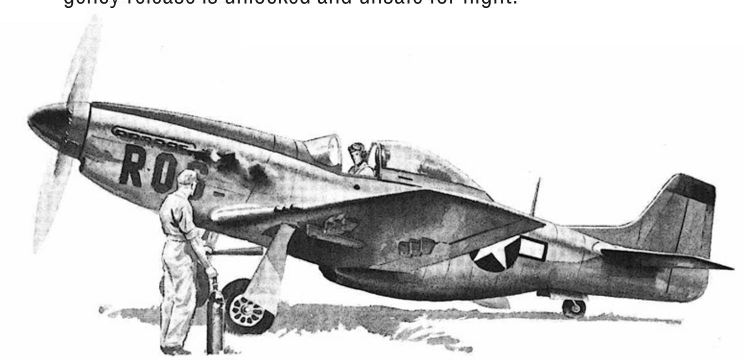
Preliminary Check

- Obtain flight clearance.
- Check outside of airplane carefully. Remove pitot cover.
- Check service of ship and status of it on Form 1A carefully.
- Make sure chocks are in place.

Enter Cockpit

- Adjust seat and rudders for height and length.
- Check ignition switch OFF.
- Set parking brake.
- Check bomb and gun safety switches are OFF.
- See that landing gear control handle is in the DOWN position. On the P-51D, there is NO ARENS control to prevent accidental raising of gear on the ground.
- Unlock controls and check for freedom of movement. Control lock is located at the base and just forward of the stick. Pull the plunger on the left side of the lock to unlock controls.
- Fasten safety belt and shoulder straps.
- Set altimeter to correct barometric pressure.
- Oil and coolant shutters to full OPEN position as soon as battery cart is plugged in.
- Set trim tabs. Rudder 5° Right, Elevator 2° to 3° Nose UP (with 25 gallons or less in fuselage tank). Elevator 1° to 3° Nose DOWN (fuselage tank full). Aileron 0° for Take-Off.
- Release hydraulic pressure with wing flaps and flap handle to UP position.
- Close canopy (bubble) as follows:
- Push in on axle of crank on right side of cockpit to engage clutch.
- Disengage pin on crank handle from the holes on the face of the clutch housing by pulling crank knob inboard gently.
- Turn crank counterclockwise, holding knob inboard to close canopy.

Warning - If red indicators show through openings on each side of the forward end of the enclosure, the emergency release is unlocked and unsafe for flight.



Starting & Warm-Up

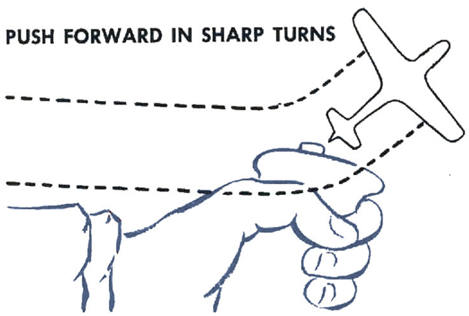
- Ignition switch OFF.
- Have prop pulled through if it has been idle more than 2 hours.
- Generator and battery switch ON, unless battery cart is being used, then battery switch OFF.
- Throttle 1 inch open.
- Mixture control in IDLE CUT-OFF.
- Propeller control in INCREASED RPM.
- Supercharger switch in AUTOMATIC.
- Carburetor air control in RAM AIR.
- Turn ignition switch to BOTH.
- Fuel shut-off valve ON and fuel selector valve to Fuselage tank (if full), or Left Main tank if Fuselage tank not serviced.
- Fuel booster pump on NORMAL and check for 8-12 pounds of fuel pressure.
- Prime engine 3 to 4 shots when cold. 1 to 2 when warm.
- See that prop is clear.
- Lift guard on starter switch on pilot's switch panel and press switch to START. Caution in use of starter not to overheat.
- As engine starts, move mixture control to RUN. If engine does not fire, after several turns, continue priming.

Warning: When engine is not firing, mixture control should be in IDLE CUT-OFF.

- Warm engine at approximately 1300 RPM. Check for constant oil pressure. If no oil pressure or low pressure after 30 seconds, shut off engine.
- Check all instruments for proper readings.
- Check hydraulic system operation by lowering and raising flaps. Loading 800-850 pounds and unloading at 1050-1100 pounds.
- Check communication equipment for proper operation.
- Uncage all gyro instruments.
- Check both LEFT and RIGHT MAIN and FUSELAGE fuel systems by rotating fuel selector valve with booster pump switch in EMERGENCY. Check for 14-19 lbs/sq. in. If drop tanks are installed, check fuel flow by rotating fuel selector control.

Taxiing Instructions

- Check wing flaps UP.
- Have wheel chocks pulled.
- Steer a zigzag course.
- Taxi with stick slightly aft of neutral. This will lock the tail wheel. In the locked position the tail wheel may be turned 6° to the right or left by use of the rudder pedals. For sharp turns, push stick forward of the neutral position to allow the tail wheel full swiveling action. Use brakes as little as possible.
- Always taxi with the WING FLAPS UP and the OIL AND COOLANT SHUTTERS in the open position.



Before Take-Off (Run-Up)

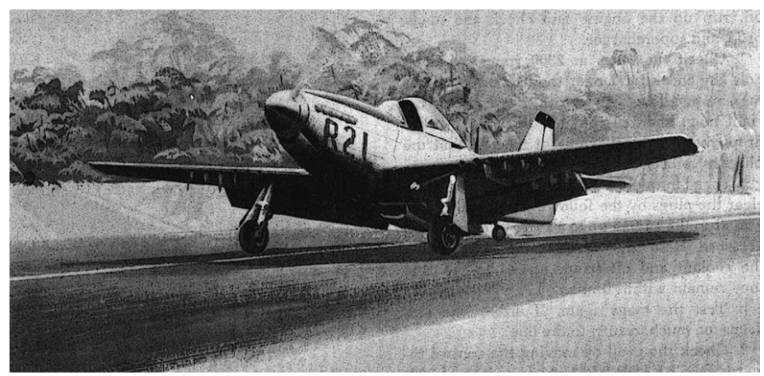
- At 2000 RPM, check the following:

Suction:	3.75 to 4.25 inches HG.
Hydraulic Pressure:	800-1100 lbs/sq. inch.
Ammeter:	not to exceed 50 amps.

- Check the instruments for the following limitations:

	Desired	**Maximum**
Oil Pressure	70-80 lbs/sq. in.	90 lbs/sq. in.
Oil Temperature	70° C - 80 ° C	90° C
Coolant Temp	100° C - 110 ° C	121° C
Fuel Pressure	12-16 lbs/sq. in.	19 lbs/sq. in.

- Check mags at 2300 RPM. Maximum drop 100 RPM.
- At 2300 check propeller - 300 RPM maximum drop - and return to full INCREASE RPM.
- Oil and coolant shutters AUTOMATIC.
- Wing flaps 20° if desired.
- Mixture RUN.
- Propeller in full INCREASE RPM.
- Fuel booster pump ON, check for 14-19 lbs/sq. in.
- Generator switch ON.



Takeoff

After you have pulled out and lined up on the runway, make sure that the steerable tailwheel is locked-it must be locked with the stick back for takeoff.

Then advance the throttle, gradually and smoothly, to 61” of manifold and 3000 rpm.

Don’t hoist the tail up by pushing forward on the stick until you have sufficient airspeed to give you effective rudder control.

This is important to watch in the takeoff, since the P-51, like all single-engine planes, has a tendency to turn left because of torque. If you force the tail off the ground too quickly with the elevators, better be ready to use right rudder promptly.

Keep the airplane in a 3-point attitude until you have plenty of airspeed. In a normal takeoff, the rudder trim tab is sufficient to make the torque almost unnoticeable.

Use Of Power

	Manifold Pressure	RPM	Mixture Control
Take-off	61” Hg	3000 RPM	RUN
Climb	46” Hg	2700 RPM	RUN
Cruise	30”-43” Hg	1800-2500 RPM	RUN

Before Landing

- Mixture RUN.
- Oil and coolant shutters AUTOMATIC.
- Fuel selector to fullest tank. NOTE: Never land on droppable wing tanks.
- Booster pump switch to ON.
- RPM increased to 2600.
- Normal gear procedure:
    - Retard throttle to check landing gear warning light (17”-22” M.P.).
    - IAS 170 or below. Put landing gear handle in DOWN position.
    - Allow time for gear to extend.
    - Retard throttle to check warning lights. If light does NOT come ON at previously noted position of throttle, gear is DOWN and LOCKED.
- Lower flaps as desired. Full flap speed 165 or below.

After Landing

- Raise flaps.
- Booster pump OFF.
- Oil and coolant shutters OPEN.
- Run engine to 1500 RPM, set mixture control to IDLE CUT-OFF and move throttle fully open.
- Turn ignition switch OFF after propeller stops turning.
- Fuel shut-off valve OFF.
- Turn all switches OFF.
- Lock controls.

Emergency Wing Flap Operation

There is NO emergency wing flap operation provided on the P-51D as the hand pump has been eliminated. On all earlier models of the P-51, emergency operation is as follows:

- Put flap selector to desired position and operate the hand pump until it siezes. Flaps will be in desired position and will stay there until another selection is made.

Emergency Landing Gear Extension Procedure

- If normal extension fails, recheck landing gear warning light by retarding throttle until landing gear warning light comes on.
- At an IAS of 170, put gear handle in down position and yaw plane. Recheck landing gear warning light by retarding throttle blow 20” M.P.
- If the landing gear warning light is still ON, indicating gear not down and locked, pull fairing door emergency release knob and yaw the plane again to lock gear.
- Then again retard throttle to check warning light.

  Note: The warning light does NOT indicate the position of the tail wheel. If there is any doubt as to whether or not the tail wheel is down, dive the airplane a short distance and pull out with enough acceleration to force down the tail wheel. REMEMBER - THE ONLY CHECK AVAILABLE FOR THE MAIN GEAR IS THE WARNING LIGHT. USE IT!

Alternate Procedure for Operating Oil & Coolant Shutters on the P-51D

- If AUTOMATIC operation of oil and coolant shutters fail due to thermostat or AUTOMATIC circuit failure,
- Check circuit breaker. If it has popped out, push it back in. If it won’t stay in, hold it in and
- Hold switch in manual OPEN (or CLOSED) long enough to open (or close) shutters, (approximately 15-20 seconds).

  Warning: do not hold circuit breaker in too long as it may start an electrical fire.

The above is an ALTERNATE procedure ONLY. If the electric motors are burned out, there is NO EMERGENCY PROCEDURE.

Emergency Exit

- The cockpit enclosure may be released as a unit in an emergency. The Emergency Release handle is located on the right forward side of the cockpit. To release the canopy, pull the handle all the way back. Remember: Duck your head as you pull the handle to avoid a head injury.
- To bail out, either of two procedures may be followed:
    - Release canopy, roll airplane over on its back and drop out.
    - Release canopy, climb out of cockpit, lower yourself onto the wing and roll off.

Drop Tanks

- When the drop tanks are installed, the gear may not retract or extend properly due to aerodynamic forces causing a suction between the drop tanks and the fairings on the landing gear; to break this suction it is necessary to yaw the airplane from side to side.

Go Around Procedure

Don't hesitate to go around if there is any possibility of getting into trouble while landing.

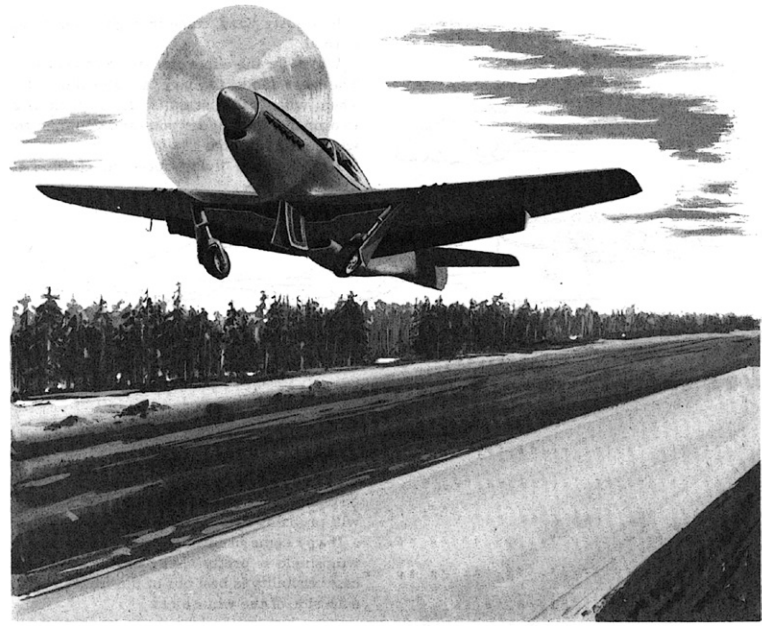
It's done in the best of families. The recommended go-around procedure is:

- Advance the throttle quickly but smoothly to a manifold pressure of 46" at 2700 rpm.
- At the same time, counteract left torque by using right rudder and right trim tab.
- Then trim the airplane to relieve the elevator pressure.
- Raise the landing gear.
- After your IAS reaches 120 mph, and you have attained an altitude of 500 feet, raise the flaps. Bring them up gradually, about 10° at a time. Watch the change of attitude as the flaps are raised.

Remember: Don't jerk or jam on the throttle. Use all controls smoothly, and pull up gradually to avoid risking a stall.

If you have rolled the elevator trim tab back for the intended landing, it may take considerable forward stick pressure to keep the nose down until you can re-trim the plane.

Most important of all in going around, continue on a straight course. Don't attempt any turns until your flaps are up.



The P-51 is one of the sweetest-flying fighter planes ever built. It is very light on all controls and stable at all normal loadings.

Although light on the controls, it is not so sensitive that you would call it jerky. Light, steady pressures are all you need to execute any routine maneuver.

At various speeds in level flight or in climbing or diving, the control pressures you have to hold are slight and can be taken care of by slight adjustments on the trim tabs. However, the trim tab controls are sensitive; use them carefully. The rudder and the elevator trim change slightly as the speed or power output of the engine changes.

The airplane is entirely normal in its flying characteristics. If you've trimmed for normal cruising speed; the airplane will become nose heavy when you raise the nose and decrease airspeed.

Under the same normal cruise conditions, when you lower the nose and increase speed, the airplane becomes tail heavy in direct proportion to the speed.

When you lower the flaps, the airplane becomes nose heavy. When you raise the flaps, the airplane becomes tail heavy.

When you retract the landing gear, the airplane becomes tail heavy. When you lower the landing gear, the airplane becomes nose heavy.

Limitations for the airplane are given in the illustration above. These limitations are for all normal flying.

For your convenience, maximums and minimums for the engine are given in the airplane on a placard on the right side of the cockpit.

Flight limitations for the airplane are also given on this placard.

The P-51 does not hold a sustained sideslip. The aileron control is not sufficient to hold the airplane in a side-slipping angle. However, you can sideslip it long enough to avoid enemy fire in combat. When any side-slipping is attempted, be sure to recover completely above 200 feet.

Full Fuselage Tank

Be especially careful in handling the stick when the fuselage tank contains more than 25 gallons of gas. In this case the flying characteristics of the airplane change considerably-increasingly so as the amount of fuel in the tank is increased.

When you are carrying more than 40 gallons of fuel in your fuselage tank, do not attempt any acrobatics. The weight of this fuel shifts the center of gravity back so the airplane is unstable for anything but straight and level flight.

Be sure you are accustomed to the changed flying characteristics of the airplane before engaging in any maneuvers with a full fuselage tank. You need at least one or two hours of flying with the plane in this condition to accustom yourself to it.

Reversibility

With the fuselage tank full, the center of gravity of the airplane moves back so far that it is almost impossible to trim the airplane for hands-off level flight. Also, as soon as you enter a tight turn or attempt a pullout, the stick forces reverse.

For example, in a turn you naturally start out by holding back on the stick. But soon you find the airplane wanting to tighten up, and you have to push forward on the stick to prevent this.

The same thing happens in a dive. The airplane tends to pull out too sharply, and you have to change from holding back on the stick to pushing forward on it to keep the airplane in a proper pullout.

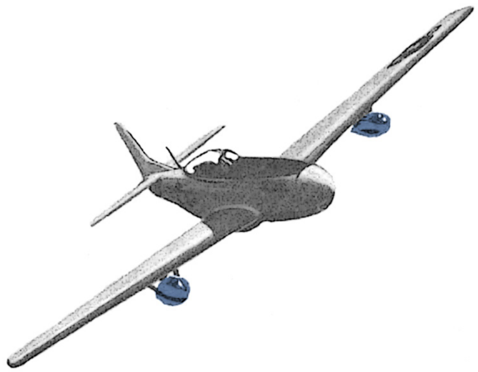
This is called reversibility. You'll encounter it in the P-51 only when the fuselage tank has a considerable quantity of gas in it. Be prepared in this situation. It is easily handled; just don't be surprised when it happens.

The stability of the airplane improves rapidly as you use up the gas in the fuselage tank. By the time the tank is half empty, only a slight tendency to tighten up is noticeable. It still is impossible to trim for hands-off level flight at this time, but this condition rapidly disappears as the fuel in the tank drops below the half-full level.

The P-51D's reversibility characteristics have been improved by the addition of a 20-pound bobweight to the elevator control system bellcrank.

This weight reduces the amount of forward pressure you'll have to exert to overcome the reversibility tendency.

With Extra Wing Tanks



When the airplane is carrying droppable fuel tanks, only normal flying attitudes are permitted.

Don't try anything but normal climbing turns and decents when you're carrying extra wing tanks.

Low Level Flight

When you're flying on the deck, trim the plane for a slightly tail-heavy condition. By doing so you'll avoid the risk of flying into the treetops if your attention is momentarily distracted from the controls.

High-Altitude Characteristics

The high-altitude characteristics of the P-51 are equal to those of any other fighter plane, and in many respects are superior. With the 2-stage, 2-speed supercharger in operation, there is plenty of power up to well above 35,000 feet.

As in any airplane, the higher you go, the farther you have to move the controls to get the same results. To make a turn at 35,000 feet, for example, you have to move the controls considerably farther than to make the same turn at 10,000 feet, if your true airspeed is the same in both cases. The air up there is so thin that it takes a lot more of it to exert an equal pressure on the control surfaces.

The supercharger blower will automatically shift into high speed at between 14,500 and 19,500 feet. This change will be accompanied by a momentary power surge and increase in manifold pressure, until the manifold pressure regulator catches up.

There is no noticeable effect when the supercharger shifts back on decent. Therefore, below 12,000 feet notice the amber light next to the supercharger switch. If the light isn't out below that altitude, raise the cover and turn the switch to LOW.

When the supercharger is in high blower, be especially careful to handle the throttle smoothly. Any rough handling causes the engine to surge. And any surging of power above 35,000 feet greatly decreases the efficiency of the airplane and increases the effort that you have to make in controlling it.

High Speed Diving

The diving characteristics of the P-51 are outstanding. Because of its clean-lined design, laminar- flow wing, exceptional aerodynamic characteristics, and small frontal area made possible by the single in-line engine, the P-51 outdives just about any airplane built.

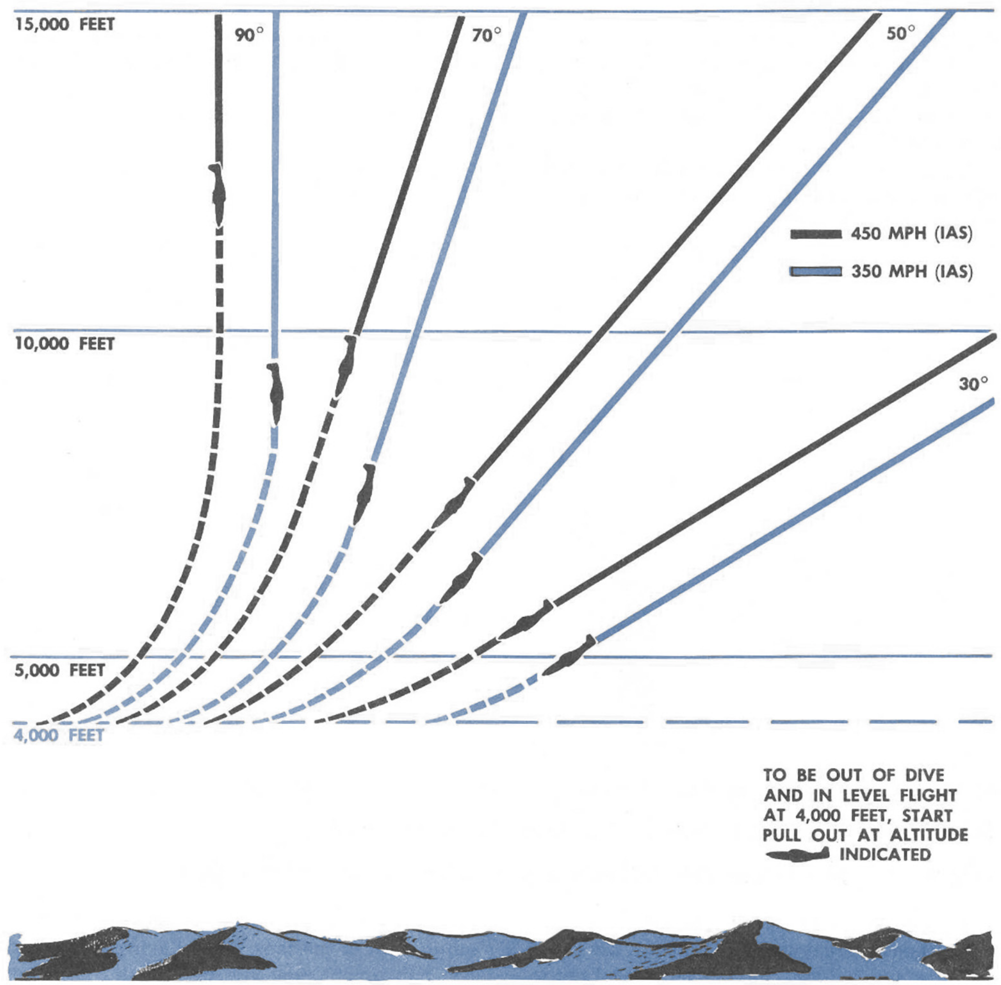
It is capable of developing terrific speeds which makes it no toy to be played with. Yet its handling, even in high-speed dives, is not difficult if you know what you're doing.

In making a high-speed dive the most important thing is to take it easy.

Since the dive, from beginning to end, is over in a matter of seconds, you don't have much time to think things out. So know exactly what you're going to do, and then do it carefully and cautiously. Above all, don't get excited.

As the ground comes up toward you terrifically fast, allow yourself plenty of altitude for the recovery. Don't dive too close to the ground.

Note the accompanying table which shows the minimum safe altitude required for pull-out from dives of various degrees. These figures are based on a constant 4G acceleration, which is about what the average pilot can withstand without blacking out.



Dive Recovery Procedure

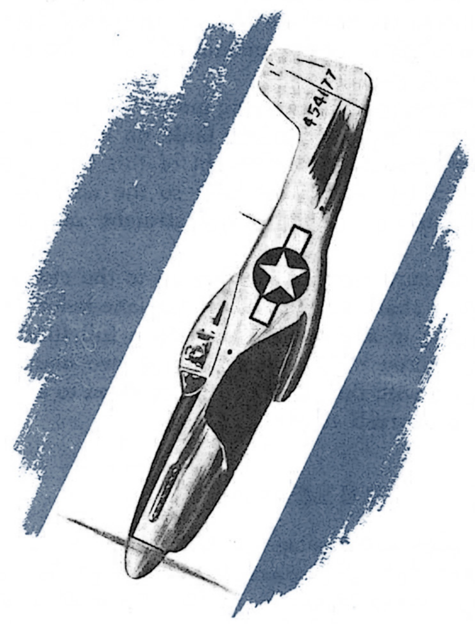
The recommended procedure for recovering from a high-speed dive is:

- Reduce the power. Don't attempt to pull out of a dive with the power on. With power on, the airplane continues to pick up speed.
- Maintain a straight course by use of the rudder. The airplane has a tendency to yaw slightly to the right in a dive so you have to counteract this with slight use of left rudder. Don't allow the airplane to yaw, and never attempt to slow down your airplane by deliberately yawing it.
- Ease the stick back. Don't jerk the stick or otherwise over-control at this time. Be sure you don't pull out abruptly.

Note that in this recommended dive recovery, you don't use the trim tabs. It isn't necessary to use the tabs, and since they are extremely sensitive, it is recommended that you don't use them. With the airplane trimmed for normal cruise, you can control the airplane in a high-speed dive with only the stick and rudder pedals.

In extremely high-speed dives, you can use the trim tabs intentionally, if you desire, but use them carefully. If you use the tabs, the following procedure is recommended:

- Trim the airplane for normal cruising.
- About halfway through the dive, use slight elevator and rudder trim, but be careful not to trim the airplane nose heavy.
- As the airplane continues to accelerate, it again becomes tail heavy- increasingly heavy as speed increases. However, make no further adjustment of the tabs. After having made this one adjustment, you can control the airplane easily with the stick and rudder. The ailerons become increasingly heavy as the speed of the airplane increases.



Maximum Allowable IAS

The maximum airspeeds for the P-51 at different altitudes are given in the accompanying graph. Note that the figures given are IAS (indicated airspeed) figures.

Notice that at altitudes above 5000 feet the figures are less than 505 IAS (the red-line figure on the airspeed indicator of the airplane).

At 40,000 feet, for example, the maximum safe speed is 260 IAS.

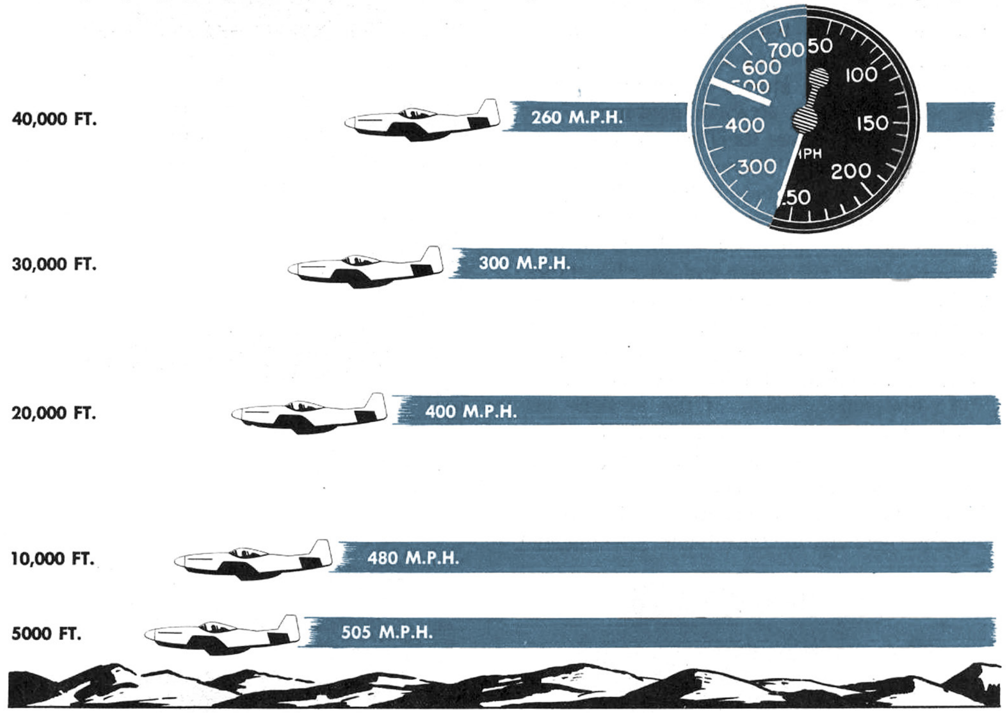
In other words, the red-line figure for the P-51 is not a fixed figure but a variable figure-variable with altitude. The higher you go, the lower the maximum allowable IAS. This is true of all ultra-fast, high-altitude fighter planes used for high-speed diving.

The usual red-line speed for an airplane (the one marked on the airspeed indicator) is the speed at which the airload on the wings and other structural members reaches the maximum that these members are designed to carry. Above this speed, the wings and other structural members, cannot safely carry the extreme airloads that develop.

In the case of high-speed fighter planes, however, a new factor enters the picture which makes diving unsafe at high altitudes long before the usual red-line speed is reached. This new factor is compressibility. It is the reason - and a good one-for the variable red-line speed above 5000 feet.

MAXIMUM ALLOWABLE IAS

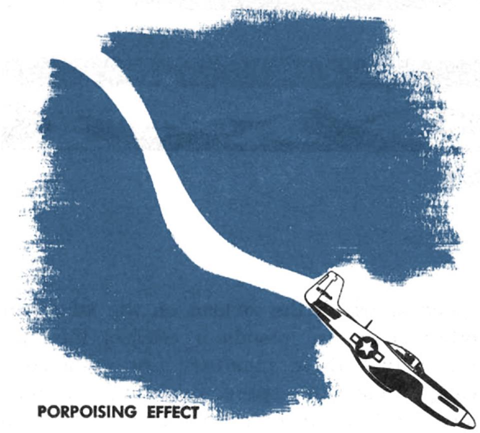
The maximum safe airspeeds for the P-51 at different altitudes are given in the accompanying graph. Note that the figures given are IAS (indicated airspeed) figures



NEVER EXCEED THESE SPEEDS

If you do, you're asking for trouble

Compressibility



Since extremely high airplane speeds have been developed oniy in recent years, the phenomenon of compressibility is still pretty much of a mystery. Scientists and engineers know comparatively little about it.

About all that is known for certain is this: Just as soon as an airplane approaches the speed of sound, it loses its efficiency. Compression waves or shock waves develop over the wings and other surfaces of the airplane. And the air, instead of following the contour of the airfoil, seems to split apart. It shoots off at a tangent on both the upper and lower surfaces.

Although there is a great deal of question as to exactly what happens when compressibility is reached, and why, there is no question as to the result, so far as the pilot is concerned.

The lift characteristics of the airplane are largely destroyed, and intense drag develops. The stability, control, and trim characteristics of the airplane are all affected.

The tail buffets, or the controls stiffen, or the airplane develops uncontrollable pitching and porpoising, or uncontrollable rolling and yawing, or any combination of these effects. Each type of high-speed fighter plane has its own individual compressibility characteristics.

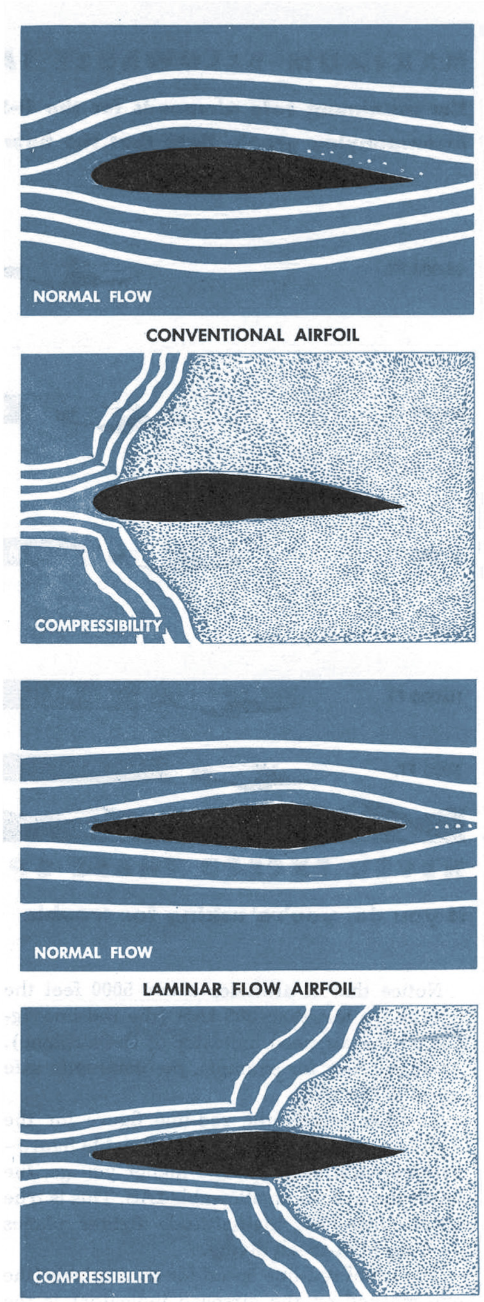
If the speed of the airplane isn't checked and the pilot doesn't regain control of it, either the terrific vibrations of the shock waves cause structural failure or the airplane crashes while still in the compressibility dive.

In your P-51, the first effect of compressibility that you feel is a "nibbling" at the stick. The stick will occasionally jump slightly in your hand. If you don't check the airspeed, this will develop into a definite "walking" stick-the stick will "walk" back and forth and you won't be able to control it. At this stage the airplane is beginning to porpoise-that is, to pitch up and down in a violent rhythm like a porpoise. As the airplane accelerates further, the porpoising will become increasingly violent.

Once the airplane begins to porpoise, you won't be able to anticipate its porpoising movements by any counter-movements of the stick.

Anything you do in this regard merely makes the situation worse. Or you may develop an aggravated case of reversibility-the control forces reverse, as they do when your fuselage tank is full and you have to. push forward on the stick in a dive to keep the airplane from pulling out too abruptly.

It is possible to come out of compressibility safely if you don't go into it too far. But before discussing the recovery procedure, here are some additional facts about compressibility.



Mach Number

An airplane goes into compressibility before actually reaching the speed of sound. Some airplanes go into it when they reach 65% of the speed of sound; some when they reach 70% of the speed of sound. It all depends on the design of the airplane.

The percentage figure at which any particular airplane goes into compressibility is known technically as its critical Mach number (named after the man who discovered this relationship between true airspeed and speed of sound).

The P-51 has one of the highest critical Mach numbers of any airplane now in combat. It can be dived to beyond 75% of the speed of sound before going into compressibility.

One of the most important factors to remember about compressibility is that the speed of sound varies with altitude. Note these approximate figures:

At sea level, sound travels 760 mph.

At 30,000 feet, sound travels 680 mph.

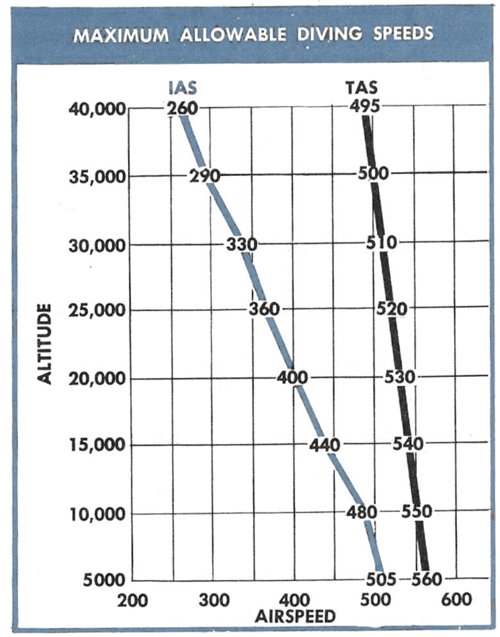
The higher you are, therefore, the sooner you approach the speed of sound. And, the higher you are, the lower your safe IAS

When you get above 5,000 feet in the P-51, the maximum safe IAS is less than the 505 IAS red line of the airplane. Above that altitude, you go into compressibility before you reach the red line on your airspeed indicator. That's the reason for the variable red line speed as given in the graph.

The accompanying illustration shows the maximum allowable safe speeds in terms of TAS as well as IAS. Notice how much these two figures differ. At 35,000 feet, for example, an IAS of 290 mph means you're actually traveling 500 mph (TAS)!

Many a pilot fails to realize this great difference between IAS and TAS at high altitudes.

Don't be fooled-study these figures carefully.



Uncontrolled Dive

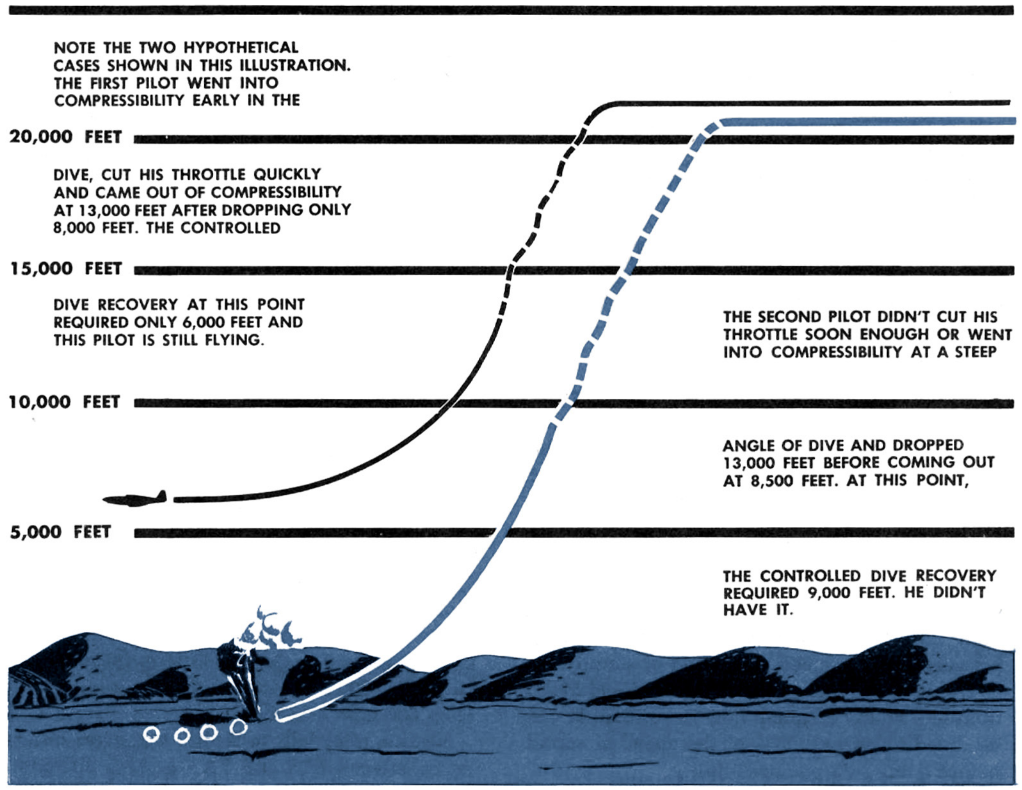
As noted earlier, it is possible to come out of compressibility safely if you don't go into it too far. The most important thing to remember about this is that while in compressibility you have virtually no control over your airplane.

While in compressibility you can aggravate your situation, you can make it a lot worse. But outside of cutting off the power (if it isn't already off) and holding the stick as steady as possible, there's nothing you can do to help the situation.

All you can do is ride it through until you decelerate enough and lose altitude to the point where your speed is below the red line speed as given in the table. This usually means an uncontrolled dive of between 8000 and 12,000 feet, depending upon circumstances. The exact distance you drop and the length of time you are in compressibility depend to a great extent upon the angle of dive in which you encountered compressibility.

Only after you have lost enough speed and altitude, do you come out of compressibility and regain control of your airplane. At that point-with the airplane again completely under your control-you can begin to come out of your dive.

Note that last sentence carefully. You can begin to come out of your dive-that's after losing 8000 to 12,000 ft. If at that point you still have sufficient altitude for a controlled dive recovery, you will be okay. If not,...?



Elevator Modification

Latest P-51D's and K's come from the factory with metal covered elevators and with decreased angle of incidence of the horizontal stabilizer. Existing airplanes will be modified in the field so that ultimately the changeover will affect every airplane of the P-51D and K series. Be sure you know the status of your plane because this modification changes some of the flight characteristics, at high Mach numbers, from those described on the preceding pages. Porpoising has been eliminated up to Mach number of at least .80. However, the elevator stick force characteristics are not as good.

When diving a modified airplane you will find that as you get close to a Mach number of .74, less and less forward pressure on the stick is required to maintain the angle of dive. As your speed exceeds .74 Mach number, you will have to start pulling on the stick to keep the nose from dropping. This pull will continue to increase with Mach number. As an example, in a dive test performed by the Flight Section of ATSC it was found that at .775 Mach number a pull of 10 pounds was required to maintain a straight forward flight path. This stick force was an increase from 0 stick force at a Mach number of 0.746. Also, a greater additional force is required to start recovery from a dive at high Mach number than from a dive at low Mach number.

The placard Mach number limit for the modified airplane is the same as for the others-.75.

So long as you don't exceed it you'll be all right, but you are sticking your neck out when you do. You won't feel serious compressibility effects if you keep your diving speed below .75

Mach number, and recovery can be made without difficulty. Exceeding that Mach number will bring on vibration of the stick, vibration of the airplane, and a wallowing motion caused by low directional stability. This means that you must start a smooth recovery. Do not wait or try to ride the dive to a lower altitude because that technique is not necessary with this airplane; smooth recovery is possible at any altitude sufficiently high.

Compressibility Recovery Procedure

If you ever get into compressibility in a high-speed dive, don't get excited.

Keep calm, and follow this recommended recovery procedure:

- Cut the power immediately. To get out of compressibility you've got to lose airspeed, so cut your throttle back.
- Release a slight amount of the forward pressure you're holding on the stick.
- Don't allow the airplane to yaw. Never deliberately yaw it to slow the airplane down.
- Hold the stick as steady as you possibly can. Don't attempt to anticipate the porpoising movement by counter-movements of the stick.
- As the airplane slowly but steadily decelerates with power off, and you get into the lower altitudes where the speed of sound is greater, the porpoising stops and you regain complete control of the airplane.
- Pull out of the dive in a normal recovery. Don't pull out abruptly. Take it as easy as altitude permits.

Notice in the above procedure that you don't use the elevator trim tab. It isn't needed.

Gliding

You can glide the P-51 safely at any speed down to 25% above stalling speed. Under average load, this is about 125 mph IAS at any level, the speed increasing with the weight of the airplane.

Although the minimum safe gliding speed increases with altitude in terms of TAS, it remains approximately the same in terms of IAS.

When the landing gear and the flaps are up, the glide is fairly flat. In this condition, however, with the nose extremely high, forward visibility is poor.

Lowering either the flaps, the landing gear, or both, reduces slightly the minimum safe gliding speed, greatly steepens the gliding angle, and increases the rate of descent.

Stalls

A stall in the P -51 is comparatively mild. The airplane does not whip at the stall, but rolls rather slowly and has very little tendency to drop into a spin. When a complete stall is reached, a wing drops. After that, if you continue to pull back on the stick, the airplane falls off into a steep spiral.

When you release the stick and rudder, the nose drops sharply and the airplane recovers from the stall almost instantly.

You'll generally be warned of an approaching stall by a buffeting at the elevators. In a power-off stall the buffeting is slight, becoming noticeable at 3 or 4 mph above stalling speed.

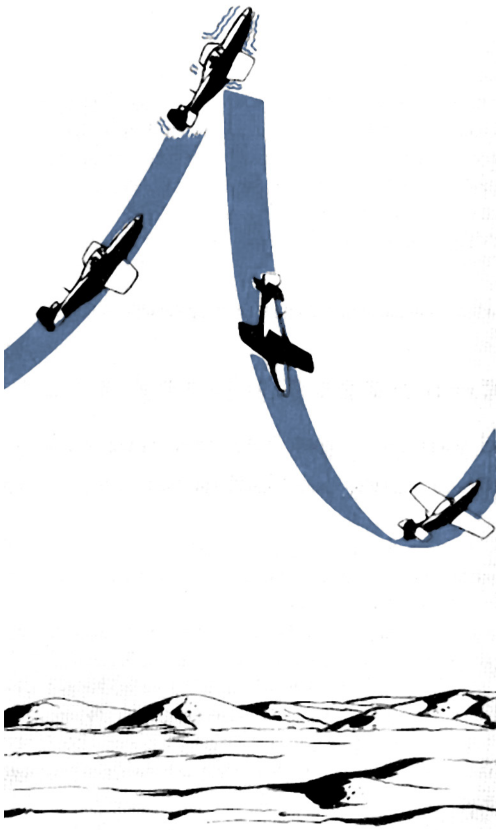
Violence of the elevator buffet increases with the speed of the stall.

The speeds at which stalling occurs vary widely, depending on the gross weight and the external loading of the airplane. Lowering the flaps and landing gear, of course, reduces stalling speed considerably.

A power stall either with wheels and flaps up or with wheels and flaps down is much more violent than a power-off stall.

Notice that while in a stalling attitude the rudder remains sensitive well after the ailerons have lost their efficiency. You can see, therefore, why a sudden application of power in making a landing will aggravate a wing-low condition.

Recovery from any stall is entirely normal. Apply opposite rudder to pick up the dropping wing and release the back pressure on the stick.



Spins

Power-off spins in the P-51D are safe enough if you have plenty of altitude for recovery. However, you'll find them quite uncomfortable because of heavy oscillations.

When you apply controls to start a spin, the airplane snaps ½ turn in the direction of spin as the nose drops to near vertical. After one turn, the nose rises to or above the horizon and the spin slows down. The airplane then snaps again, and the process is repeated.

Spins to the left will occasionally dampen out and become stable after about three turns, but in right spins the oscillations are continuous, neither increasing nor decreasing as the spin progresses.

Power-on spins are extremely dangerous and must never be performed intentionally under any circumstances. The nose remains at from 10º to 20º above the horizon, the spin tends to tighten, and there is a rapid loss of altitude.

Recovery control will have no effect on the airplane until the throttle has been completely cut back.

The spin recovery procedure recommended is the standard N.A.C.A. procedure, and is the same for both left and right spins.

N.A.C.A. Spin Recovery

- Pull the stick back and use full rudder with the spin.
- Cut the throttle.
- Apply full opposite rudder to slow and stop the spin.
- Move the stick quickly forward to pick up flying speed.

As soon as you apply opposite rudder the nose drops slightly and the spin speeds up rapidly for about 1¼ turns and then stops. The rudder force at first is light but then becomes heavy for about a second or so in the first half turn. The rudder force then drops to zero as the spin stops.

During the spin you feel a slight rudder buffeting. If you attempt to recover from the dive too soon after the spin stops, you also feel rather heavy buffeting in both the elevator and the rudder. The remedy for this condition is to release some of the pressure you have applied on the stick.

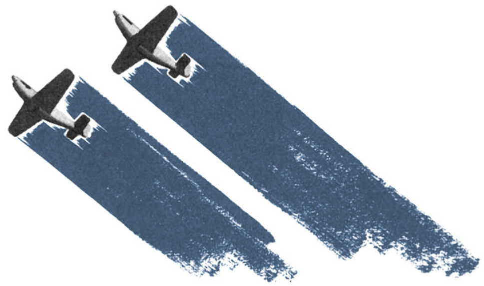
If you should ever get into a power spin, cut the throttle immediately and follow the normal recovery procedure. Be sure to hold the controls in the recovery position until you have recovered completely. It may take up to six turns to recover from a two to five turn power spin. In this situation you may lose as much as 9000 feet of altitude.

Remember these tips on spin recovery:

- Don't get excited.
- Don't be impatient. Leave the controls on long enough for them to take effect.
- Fix in your mind the altitude at which to bail out, and bail out before it is too late.
- Never make an intentional power-on spin
- In making an intentional power-off spin, start it with plenty of altitude. Be sure you can recover above 10,000 feet.

Important: If the normal recovery procedure doesn't bring you out of the spin, let the controls go.

Acrobatics



The P-51D has really exceptional acrobatic qualities; stick and rudder pressures are light and the aileron control is excellent at all speeds.

Be sure of one thing before entering any acrobatic maneuver-have plenty of altitude.

You can do chandelles, wingovers, slow rolls, loops, Immelmans, and split-S turns with ease. However, remember that you must limit inverted flying to 10 seconds because of loss of oil pressure and failure of the scavenger pump to operate in inverted position.

In a loop you have to pull the airplane over the top, as the nose won't want to fall through by itself. If you don't fly the airplane on over the top of the loop, it has a tendency to climb on its back.

The aerodynamic characteristics of the P-51D are such that snap rolls can not be satisfactorily performed. This has been proved by a long series of test flights. So don't try any snap rolls in an attempt to show that you're the guy who can do them. You'll invariably wind up in a power spin-and that's bad.

Caution: Acrobatics must not be attempted unless the fuselage tank contains less than 40 gallons of fuel.

Forced Landings on Takeoff

If your engine fails on takeoff, immediately nose the airplane down to retain airspeed. If you have sufficient runway, simply make a normal 3-point landing straight ahead. If you don't have sufficient runway, make a belly landing.

One of the most important things to remember if your engine fails on takeoff, is to land straight ahead-or only slightly to the right or left depending on obstructions. Never attempt to turn back into the field. There is only a slim chance that you can make it. Steep turns near the ground are hazardous even with power on; with a dead engine they are suicidal.

In making a forced landing on takeoff when the runway is behind you, nose the plane down and maintain a glide of about 110 mph. If you are carrying droppable fuel tanks or bombs, maintain a glide of about 120 mph and salvo the auxiliary load immediately.

Engine Overheating

If your engine overheats in flight, the trouble is probably caused by one of the following:

- You've been climbing the airplane at high power and below recommended airspeed. In other words, you aren't getting a great enough blast of air through the airscoop. To remedy this difficulty, all you have to do is level out for a while - increase airspeed but reduce power.
- The automatic shutter controls are not functioning properly. In this case, operate the shutters manually by means of the toggle switch control, and watch the instruments to see if the condition has been remedied.
- The oil supply is depleted. You discover this situation in checking the oil pressure. The engine continues to overheat even after the shutters are opened all the way. There isn't much you can do in this situation except keep the rpm and power settings at the minimum, and land as soon as possible.
- The coolant supply is depleted. Here again, the engine continues to overheat even after the shutters are opened all the way. There isn't much you can do in this situation, either, except keep rpm and power settings at the minimum, and land as soon as possible. In most cases you won't have more than 10 minutes before the engine freezes.
- You've been exceeding the operational limits of the engine. Make sure that the carburetor air control is at RAM AIR, depending upon the type of equipment. Then check the mixture control to see that it is in RUN.

Brake Failure

It is extremely unlikely that both brakes will fail at the same time. When one brake fails it is almost always possible to use the other in stopping the airplane. If one brake goes out while taxiing, use the other (good) brake, and also the lockable tailwheel.

Immediately chop the throttle and cut the switch. If you're going too fast to stop the airplane in this manner, lock the good brake, and groundloop until the airplane stops.

If a brake goes out while checking the magnetos, immediately cut the throttle back and hold the plane in a groundloop with the good brake.

If, in coming in for a landing, you know that your brakes are shot-or even if you suspect such a condition- approach the field and land as slow as safety permits. Use full flaps and use your best technique in making a 3-point landing.

Stop your engine completely by cutting the mixture control as soon as your plane is on the ground. The dead prop creates additional braking action to help make your landing as short as possible.

Hydraulic System

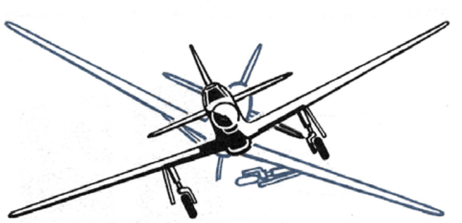
Failure

If your hydraulic system ever fails, remember that you can lower the landing gear by pulling the emergency knob. The procedure is simple:

Landing Gear Down

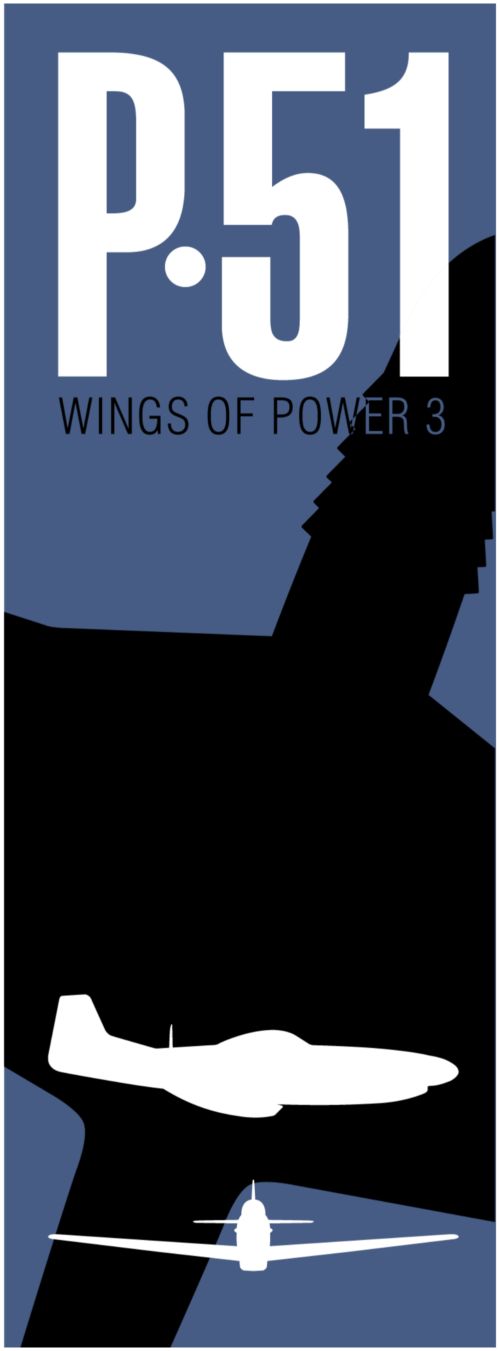
- Put the landing gear control handle in the DOWN position. This releases the mechanical locks which hold the gear in place.
- Pull the red emergency knob. This releases the hydraulic pressure in the lines and allows the gear to drop of its own weight.

Rock It to Lock It



It is possible that the gear may not fall with sufficient force to lock itself in place. Therefore, while still pulling out on the red emergency knob, rock the airplane until you feel the gear catch in the locked position.

The tailwheel usually locks without any difficulty. If it doesn't, speed up the airplane to force the partially extended wheel into position by means of greater air pressure on it. Or dive the airplane a short distance and then pull out with enough acceleration to force down the tailwheel.



Radio Set AN/APS-13

Radio Set AN/APS-13 is a lightweight radar set which gives you a visible and audible warning that another airplane is behind or approaching from the rear.

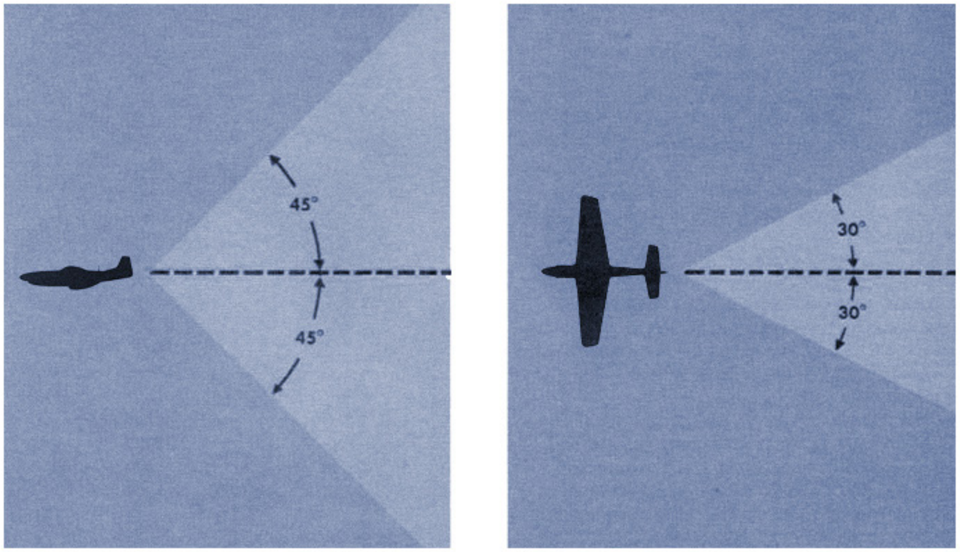
The usable range of this set is from 200 to 800 yards and within an area extending up to 30° on both sides of the airplane and from 45° above it to 45° below it. The set doesn't work below 3000 feet. Ground reflections determine the lower limit.

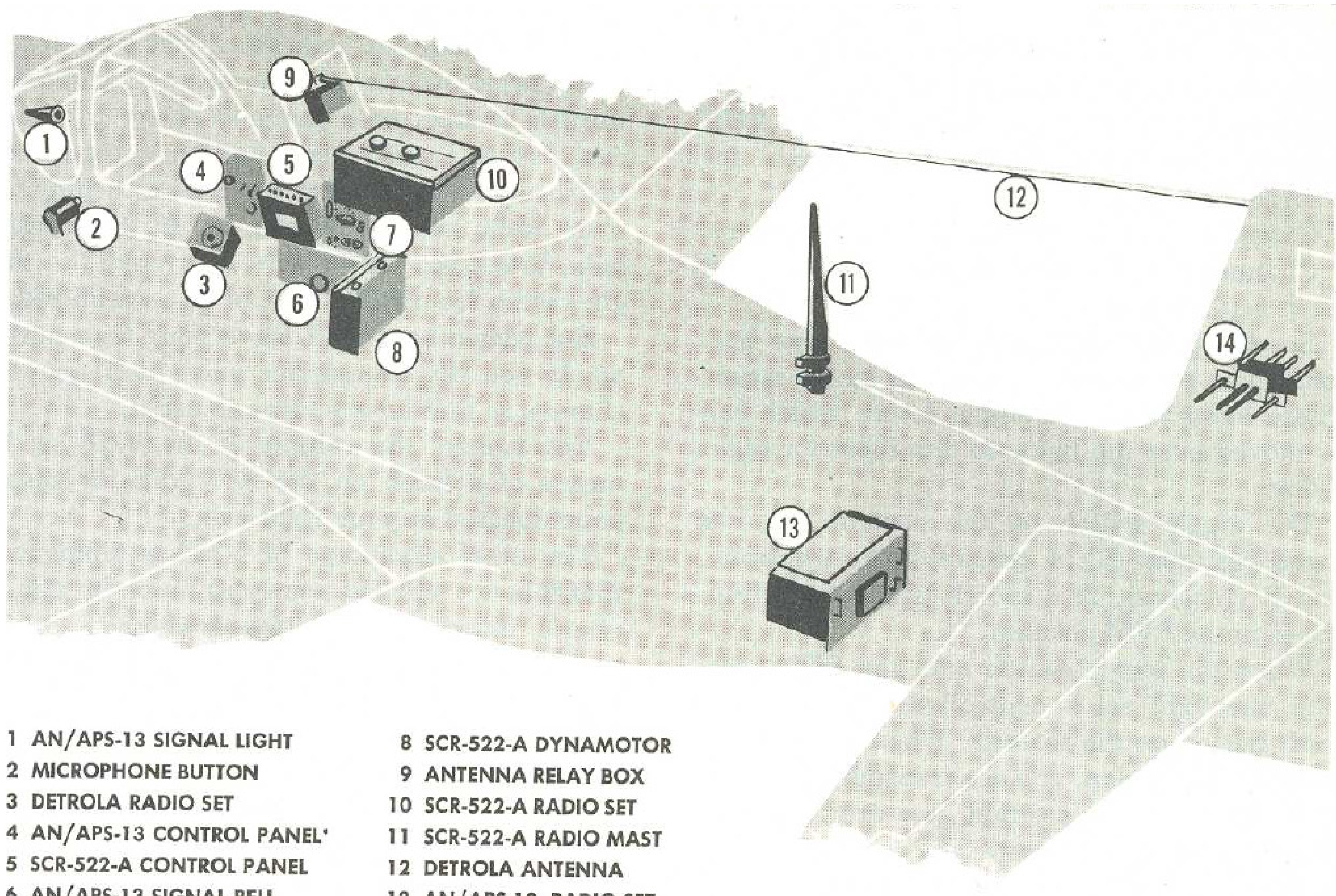
The main units include the antenna, transmitter-receiver, indicator light, warning bell, ON-OFF switch and test switch. The set operates on 27.5 volts, which is the primary aircraft power supply. The antenna is mounted on the vertical stabilizer. The red jewel indicator light is mounted on the left side of the instrument cowl, the bell is to the left of the seat. Control switches are provided on the panel at your right.

Operation

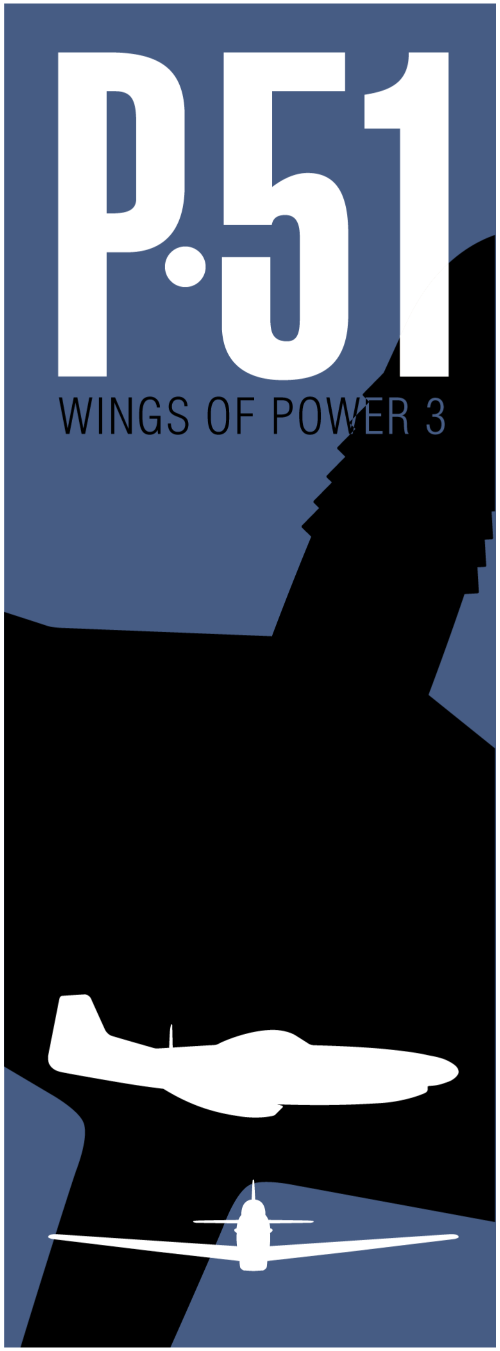
- Turn the power switch ON.
- Wait at least 30 seconds for the tubes to warm up, then hold the test switch up. If the indicator lights and the warning bell rings, the equipment is operating properly.

Note: there is no volume control for the warning bell. The volume knob on the AN/APS-13 panel is used to control volume for the radio set.





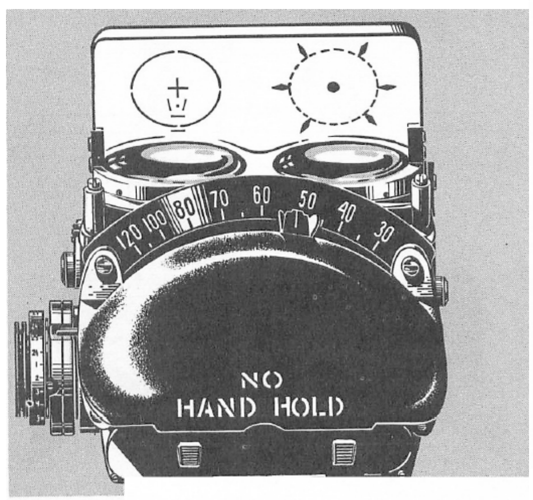
1 AN/APS-13 SIGNAL LIGHT
2 MICROPHONE BUTTON
3 DETROLA RADIO SET
4 AN/APS-13 CONTROL PANEL'
5 SCR-522-A CONTROL PANEL
6 AN/APS-13 SIGNAL BELL
7 IFF CONTROL PANEL
8 SCR-522-A DYNAMOTOR
9 ANTENNA RELAY BOX
10 SCR-522-A RADIO SET
11 SCR-522-A RADIO MAST
12 DETROLA ANTENNA
13 AN/APS-13 RADIO SET
14 AN/APS-13 ANTENNA

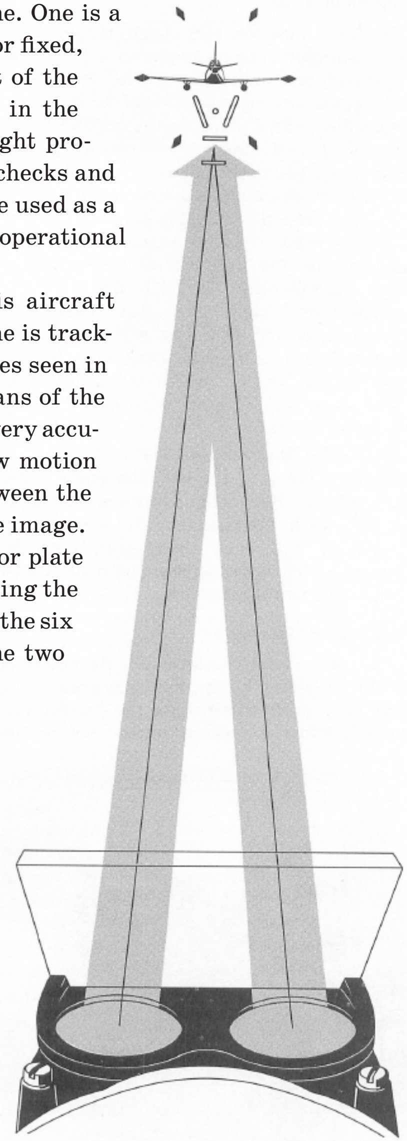


Appendix B: K-14 Gunsight

The K-14 is a single-gyro sight designed to compute automatically the correct lead to hit an airborne target with fixed guns from your aircraft. This sight is really two sights in one. One is a computing sight and the other is a noncomputing, or fixed, sight. The only difference between the fixed sight of the K-14 and the earlier fixed sights is a large cross in the centre that replaced the pipper (dot). The fixed sight provides a means of harmonization and maintenance checks and is also used for attacking ground targets. It may be used as a standby if the computing sight is inoperative. The operational range of the computing sight is 600 to 2,400 feet.

The pilot views the area directly ahead of his aircraft through the combining glass of the sight head as he is tracking the target. The movable and fixed reticle images seen in the combining glass are focused at infinity by means of the collimating lenses. Because the lenses are focused very accurately, parallax is reduced to a minimum to allow motion of the pilot's head without any apparent shift between the position of the target and the position of the reticle image. By closing the right eye and looking at the reflector plate with the left, the gunner sees the fixed ring. Reversing the process and looking only with the right eye, he sees the six diamond-shaped dots. Using both eyes, he sees the two images superimposed as shown in the illustration.





Fixed and Computing Reticles Superimposed at Infinity

Fixed reticle

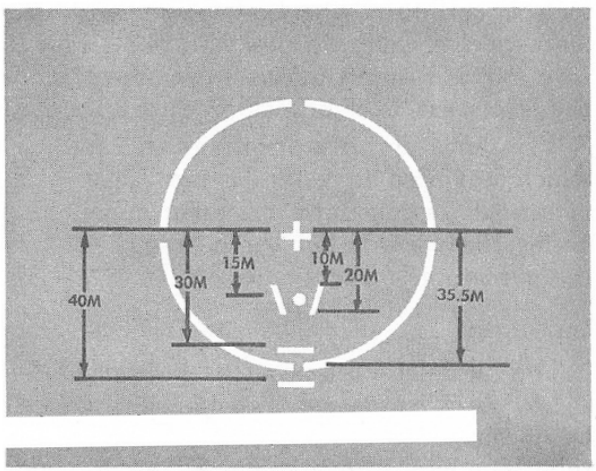
The fixed reticle image of the left sighting system is formed by a single fixed reticle perforated to form a 71.12-mil circle, and a small centrally located cross. This is commonly called the 70-mil reticle. The reticle image also includes diagonal and horizontal lines and a small dot which lies below the cross. A mask with a small hole in its center is provided to blank out all of the fixed reticle pattern with the exception of the cross. The mask is operated by a lever on the left side of sight unit.

To determine the distance or range to a target of known size at an unknown distance this formula can be applied:

$$D = \frac{S}{mil} * 1000$$

Where:
D – distance to target
S – known target size
mil – target size in mil-dots as seen through the sight.

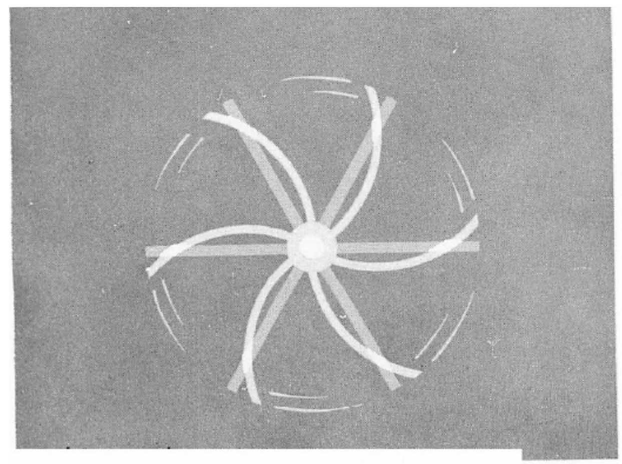
For example, if a targeted airplane has a wingspan of 70 feet and when viewed through a sight it has the same size as the 70-mil reticle, it is 1000 feet away.



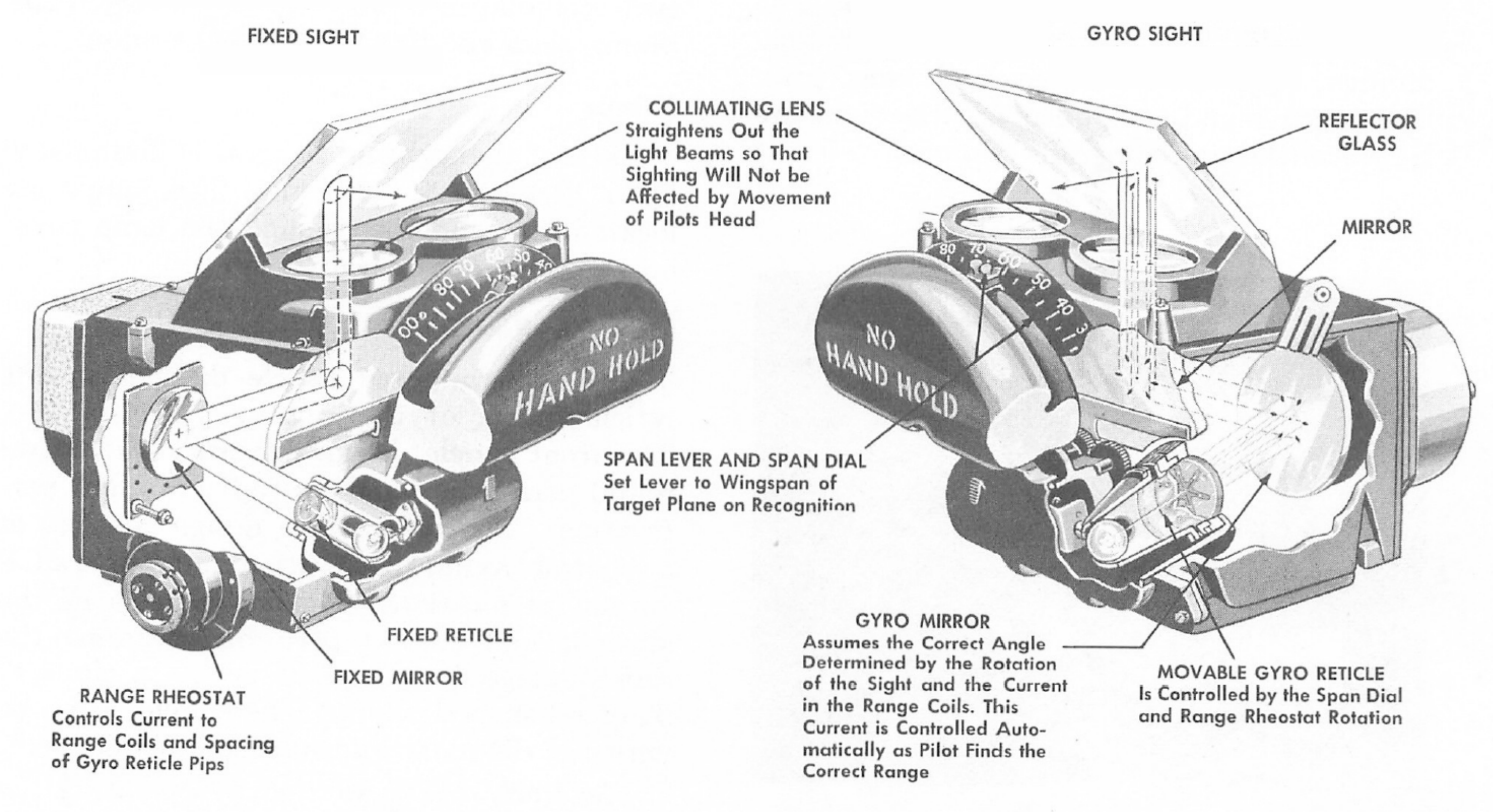
Fixed Reticle Pattern, K-14 Sight, Diameter 71.12 Mils

Movable reticles

Two superimposed reticle disks form the reticle image of the right sighting system. The front reticle design consists of a central round perforation and six radial strait perforations. The rear reticle design consists of a central round perforation and six radial curved perforations. The intersection of the straight and curved perforations forms the reticle image for the right eye –a circle of diamond-shaped dots. The circle can be varied in diameter by rotating either element. The front disk is rotated by operating the span control knob, located on the front of the sight unit. This sets the position of the front disk to give in feet a circle diameter proportional to the known wingspan of the target aircraft. The rear disk is geared to the range drum on the left side of the housing, which is connected to the rotating throttle grip. A range drive-cable system enables the pilot to rotate the rear reticle disk and thus to adjust the diameter of the reticle image to frame the target and automatically set the range into the sight.



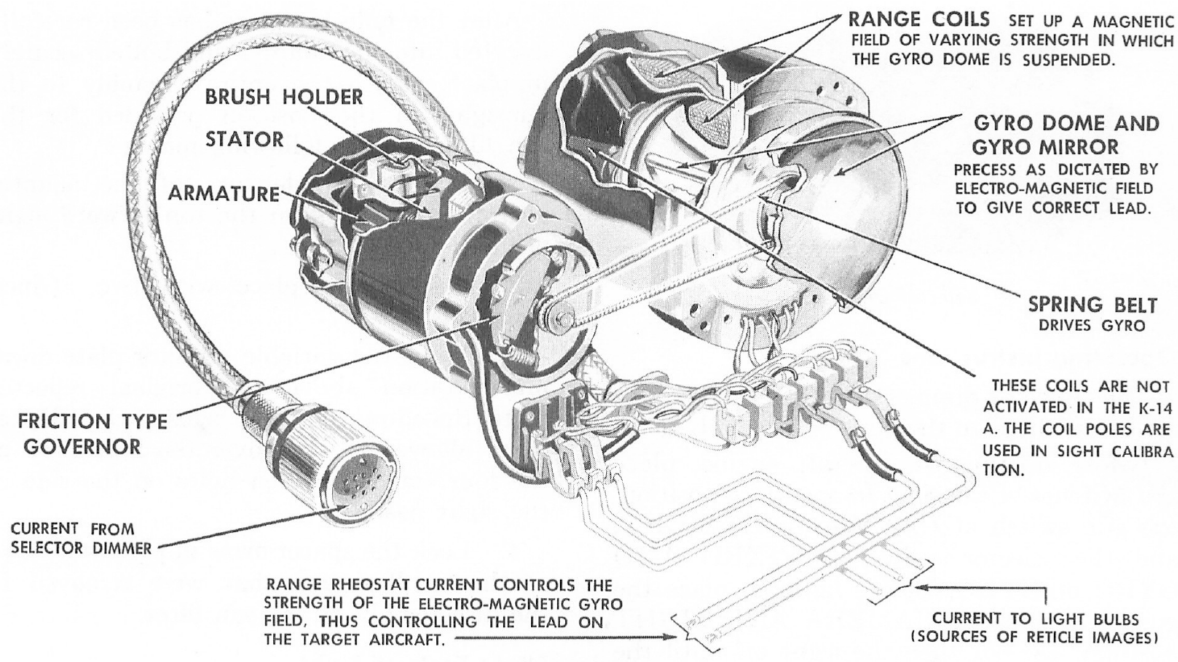
Movable Reticles



The image of the movable reticle is not fixed in space as is the fixed-sight image. Its position is controlled by the action of the gyroscope, which computes the necessary lead. The range is determined by setting in the wingspan of the target and adjusting the size of the imaginary circle formed by the inner points of the six diamond-shaped dots to frame the target. When this is done, the reticle image is shifted the proper amount to provide the correct lead.

In operation, the gyroscope unit, together with the sight and associated equipment, makes the necessary correction so that the angle between the axis of the gun bore and the line of sight equals the correct lead. The position of the movable retile image is gyroscopically and electrically determined by the gyroscope unit as follows:

The gyroscope assembly is spun by the small, direct-current motor at high rpm. The assembly, which includes the mirror, stem, and dome, is mounted on the universal joint and has the characteristics of a gyroscope. The assembly is shown in the illustration.



Gyro Function

There are two main factors which determine the angle by which the gunbore axis leads the sight line. They are the range of the target and the angular tracking rate. Angular tracking rate is proportional to target speed, attacking speed, and velocity.

When the target is framed, the amount of current that flows in the range coils for the particular range determines the strength of the magnetic field produced by the range coils. When the aircraft is turned to follow the target, the gyroscope assembly, including the gyroscope mirror, tends to remain fixed in space while the aircraft and sight housing rotate about the gyroscope. The range coils, which are secured to the sight housing, also shift their position relative to the spinning dome. The forces set up by the magnetic field of the range coils are no longer central with respect to the dome. Therefore, the dome immediately tends to precess toward the new location of the magnetic center where the forces are again equal.

If the aircraft continues to turn, however, drag forces set up in the spinning dome cannot precess the gyroscope assembly to the central position. Consequently, the gyroscope assembly assumes a h respect to the flight path of the aircraft. This angular position remains constant as long as the rate of turn of the aircraft and the rate at which the gyroscope is being precessed toward the magnetic center are equal. The angular displacement of the gyroscope mirror relative to the flight path of the aircraft determines the position of the movable reticle image with respect to the central position, and this determines the angle that the gun-bore axis assumes with relation to the line of sight.

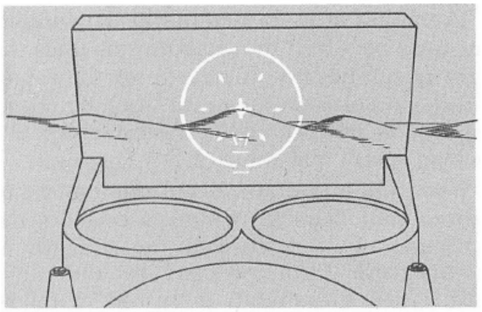
When the aircraft turns, as in tracing a target, the gyroscope (mirror, stem, and dome operate as one) tends to maintain a fixed plane of rotation, and the angle between the axis of the gyroscope and the flight path changes accordingly. This change of angle is restrained electrically by means of the coils in the coil housing.

The electrical force is used to control the position of the gyroscope mirror and thus determine the position of the movable reticle image.

The gyroscope dome is located so that it spins between the range coils and cuts the magnetic field created by the two coils. Small currents, known as eddy currents, flow in the spinning dome in such a way as to produce an induced magnetic field which opposes the original magnetic field produced by the range coils. The field produced by the currents flowing in the spinning dome tends to oppose the displacement of the gyroscope axis from center. When the aircraft is in straight-and-level flight, the drag forces hold the gyroscope in its neutral position and the movable reticle image remains centered with respect to the fixed reticle image.

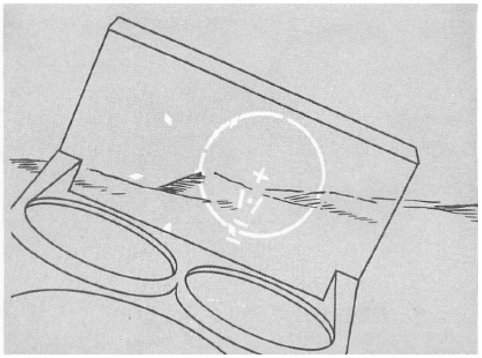
Test one:

1. After the sight has warmed up, set the selector at FIXED AND GYRO, move the fixed reticle mask lever up, and set the range at 2,400 feet (the smallest reticle diameter).



Superimposed Fixed and Computing Reticles

2. Establish a steady turn at a rate which will deflect the pipper of the moving reticle to the circumference of the fixed reticle ring. That is a 35-mil deflection, as shown in the illustration.



3. Holding this rate of turn constant, note the time indicated by the second hand of the clock when the directional gyro passes 0 degrees mark.
4. Maintain a constant rate of turn by keeping the pipper on the ring with a 35-mil deflection for 60 seconds.
5. Note the position of the directional gyro after 60 seconds have elapsed.

The correct amount of time to complete the turn should be 130 degrees plus or minus 10 degrees.

Test two:

1. After the sight has warmed up, set the selector at FIXED AND GYRO, move the fixed reticle mask lever up, and set the range at 1,000 feet.
2. Establish a steady turn at a rate which will deflect the pipper of the moving reticle to the circumference of the fixed reticle ring. That is a 35-mil deflection, as shown in the illustration.
3. Holding this rate of turn constant, note the time indicated by the second hand of the clock when the pipper passes through some prominent point on the horizon.
4. Maintain a constant rate of turn by keeping the pipper on the ring with a 35-mil deflection until the pipper has again passed through the same point, indicating a 360 degree turn and check the time at the instant it passes through the point.

The correct amount of time to complete the turn should be 60 seconds, plus or minus 5 seconds.

Before starting the engine set the gunsight gyro power switch to ON. Do not turn the gyro off until the aircraft is landed and the engine is turned off. The reason for this is that engine vibration and landing shocks may damage gyroscope pivots if the unit is not operating.

The selector-dimmer and should be set as needed.

In normal conditions the fixed reticle mask is set, so that only small cross is visible as reference. The full, unmasked fixed sight is used as a backup or for attacking ground targets.

Set the gun switch at CAMERA AND SIGHT or GUN, CAMERA AND SIGHT to power up the sight.

Set the selector switch at FIXED AND GYRO or GYRO to display the movable reticle.

SPAN SETTING

Keep the SPAN SETTING knob set at the wing spread of the aircraft most likely to be encountered. As soon as the aircraft is recognized, check the setting and alter if necessary. If exact recognition is not possible, but the number of engines is known, set the span knob at 35 feet for a single-engined aircraft, 60 feet for a two engined aircraft and 110 feet for a four engined aircraft.

PICKING UP AIM

When picking up a target or when shifting from one target to another, it may be necessary to execute violent maneuvers. While doing this the twist grip should be turned clockwise to minimum range (200 yards) until the aiming bead is near the target, you can then turn the twist grip to properly frame the target. This method reduces overranging, permits the pilot to place the center aiming dot more quickly on the target and prevents overcorrection and tumbling gyro.

TRACKING

When tracking a target, it is necessary to smoothly maneuver the ship so that the center dot will be on the target at all times. Accuracy requires that the target be tracked for a minimum of 1 second before firing.

RANGING

The correct range is electrically transmitted into the sight when the span setting knob is correctly set, and the twist grip is adjusted until the moving reticle properly frames the target. In normal combat, range is changing all the time and the reticle must be made to frame the target continuously. Some judgment is required to fit the reticle to the target plane when neither its wings nor its fuselage are at right angles to the line of sight. In these cases, the imaginary circle of the reticles must be made larger than the target.

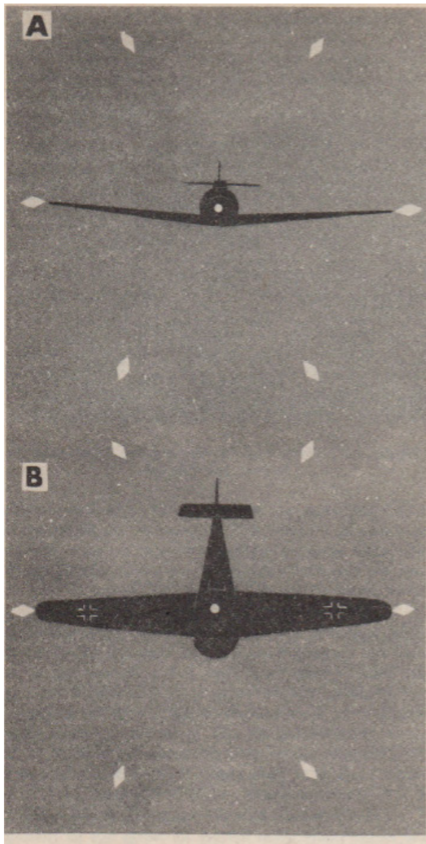


Figure 27—Wings at Right Angle to Line of Sight

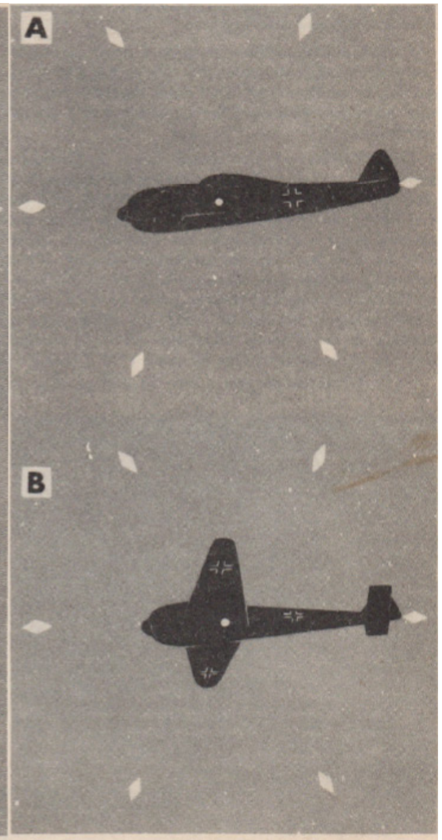


Figure 28—Fuselage at Right Angle to Line of Sight

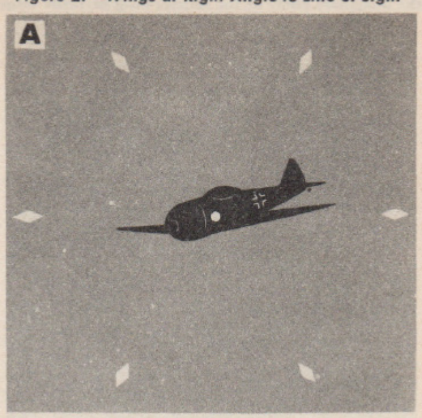


Figure 30—Wings and Fuselage at 45 Degree Angle to the Line of Sight

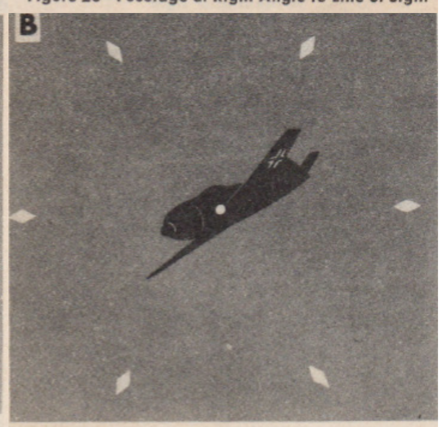
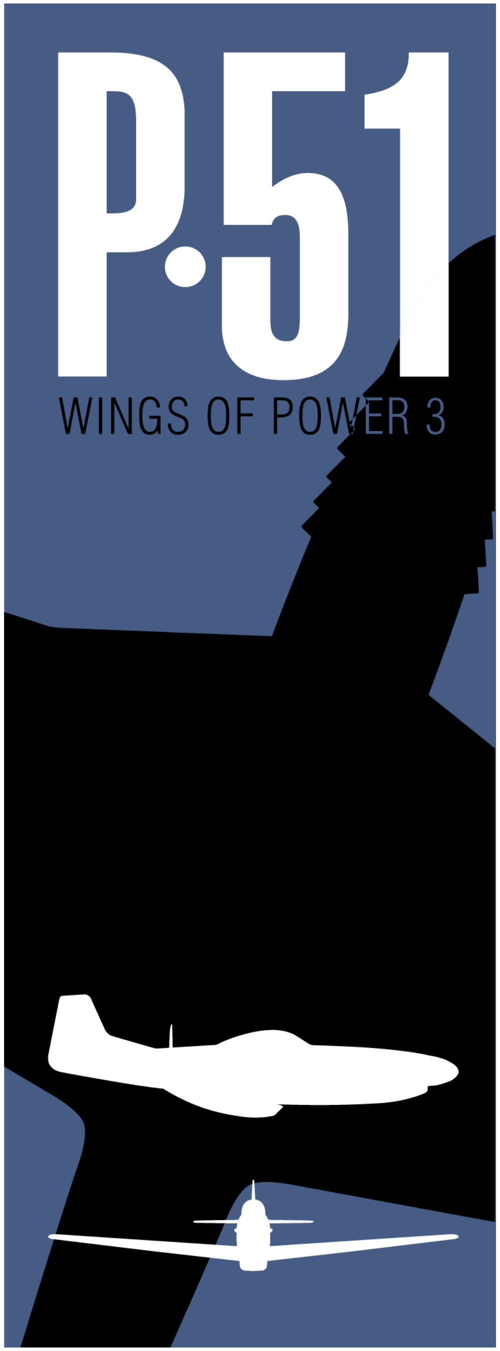


Figure 29—Wings and Fuselage Not at Right Angle to the Line of Sight



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Very Special Thanks to our friends and families who stuck by us and worked hard to support our efforts.

Your loyal girl patiently waits for your next flight.
She is quite the special aircraft and she is your responsibility.
Take care of her...

From all of us at A2A Simulations,

thank you