P-51

WINGS OF POWER 3

CIVILIAN MUSTANG

A2A simulations

Wings of POWER III "P-51"

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

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"Passion for Flight"

Wings of POWER 3

"We put you in the cockpit of the world's most exciting aircraft."

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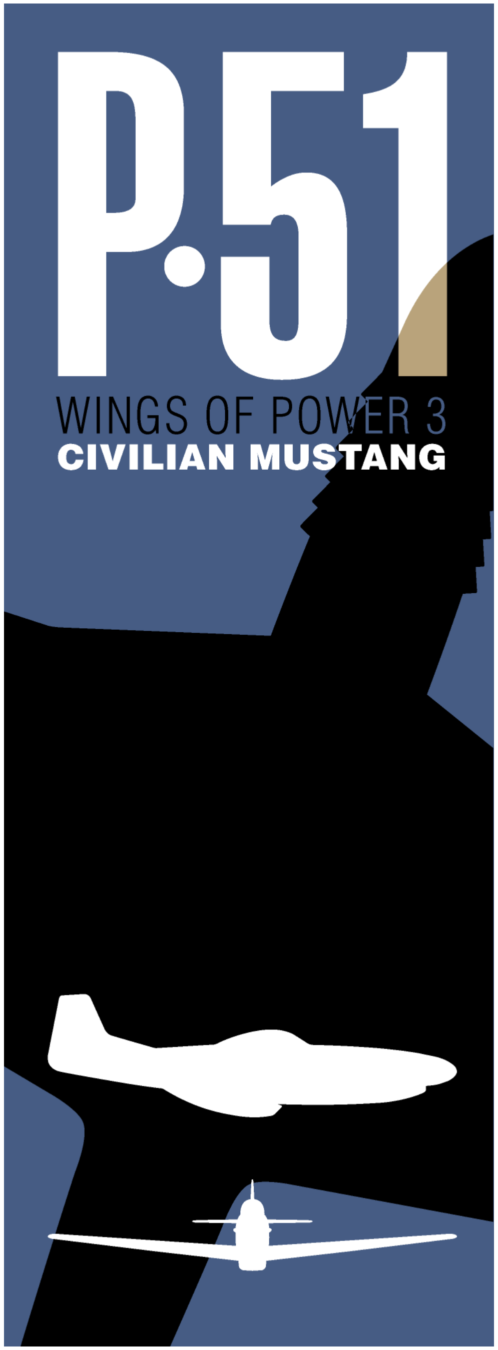


Foreword

A Mustang for the People

Aeroplane enthusiasts are well-aware that the P-51, primarily the “D” model, was the pre-eminent U.S. Army Air Force fighter of W.W. II and is arguably the best piston engine fighter of all time due primarily to its excellent range and speed. When hostilities ended in the Pacific theatre on 2 September 1945 with the surrender of the Empire of Japan on board the U. S. S. Missouri, an enormous inventory of used and surplus military equipment, including tens of thousands of aeroplanes of all types, including, of course, thousands of quite beat-up P-51B, C and Ds were slated to be chopped into scrap metal. While P-51Ds and Hs remained in the Army Air Force’s inventory as a first-line fighter aircraft, those high - time veteran Mustangs which were no longer deemed to be serviceable or recoverable to A. A. F. standards were sent to the slag heap. This was the first of two separate opportunities for the public to purchase a Mustang directly from the Air Force; the second occurring when the Air Force retired the Mustang and dumped its entire inventory of operational F-51s on the public market in 1956; but more about that anon.

Immediately after the end of W. W. II, such aircraft which were deemed to be “flyable” (a very loose and questionable appellation with regard to the majority of such so-deemed examples) by the A. A. F. were, for a very short time, offered to the public in “as is” condition, which condition was truly not often much more than just barely able to stand on its wobbly partially extended landing gear. The greatest number of these aeroplanes had seen a lot of hard service, some having been shot up pretty badly in combat and had been hurriedly pieced back together in the field, sometimes numerous times, using methods which were not always exactly and entirely reputable or trustworthy.

As it were, some select few of these surplus W. W. II P-51s were actually in fairly good shape, having never left the United States. Even among those that had seen combat, except for their worn-out Merlin engines, most of which had been sadly, but understandably much strained and abused, the airframes and the hydraulic and electrical systems were mostly in good condition. In 1945-6 these P-51B, C and Ds were a true bargain at the going price of around $1,500.00 ($1,500.00 in 1946 had about the same buying power as $18,599.34 in 2012, the average annual inflation over this period being about 3.89%) The average price of a P-51D in good condition in 2012 is upwards of around $1,500,000.00.

Aviation sportsmen and women, buyers for museums and all kinds of ex and would-be fighter pilots thronged to the sites where they could purchase the recently surplused P-51s and other types. These sites were mostly in the Southwest U.S.; Arizona, New Mexico and West Texas, places chosen for mass outdoor aircraft storage because the dry weather there tends to foster the aeroplane's preservation. At each of these sites one would typically find hundreds if not thousands of examples of war weary military combat aircraft of all kinds, from B-17s to AT-6s, lined up in long rows in fields of hundreds of acres. If you have seen the film "The Best Years of Our Lives" you may recall a scene near the end in which one of these actual sites is most graphically, significantly and ironically featured.

Upon finding a likely subject, prospective purchasers were permitted to inspect the aeroplane and to start the engine (if they knew how to). Small quantities of fuel, oil and gasoline- driven battery carts were provided for starting. No showing or proof of flying experience or even of a pilot's license was required for purchase. If satisfied, the purchaser would pony up the purchase price in cash and sign a waiver absolving and holding harmless the Army (or Navy as the case might be) for all responsively regarding the condition of the aeroplane and any mishap that might occur with regard to it after purchase. It would then be more substantially fueled, usually by a hand operated pump from a portable fuel drum, with just enough avgas to fly the aeroplane to the nearest airport, towed to a makeshift runway nearby, usually just a dusty open strip of desert, and the owner or his or her representative would fly it away.

The informality and seeming outright carelessness by which these high-performance, state of the art (for those times) aircraft were so blithely virtually given away to all and sundry may well strike us today as being somewhat remarkable if not foolhardy; yet it was so. The rate of attrition of these aeroplanes, not to mention their pilots, is not recorded; however, it would probably not surprise anyone to discover that it was very high indeed.

Not surprisingly, one of the main uses for which P-51s were put was air racing. Immediately after W. W. II highly modified surplus P-51s competed in the 1946-1949 Thomson and Bendix Trophy races as well as in the Cleveland Air Races and others which were popular in those days. P-51s mostly performed particularly well in the races that they were entered into, and most often won the long distance Bendix Trophy race. However, after a series of fatal accidents in 1949, air racing of modified military piston aircraft was banned. It was not permitted again until 1964 when the Reno Air Races brought the sport back to life. Other venues for air racing then began to pop up and pylon air racing is once again a popular entertainment and sport.

The story of one particular P-51 well- illustrates how excellently this aeroplane performed whilst in civilian hands:

THE "BLAZE OF NOON"

The great cinema and airshow pilot, the late Paul Mantz purchased P-51C-10-NT (44-10947) in late 1945 which he painted fire-engine red and named "Blaze of Noon" after Ernest K. Gann's excellent novel about the early days of flying in the 1920s, which was also made into a motion picture of that name. He intended to enter this aeroplane in the 1946 Bendix Trophy race, a transcontinental, point-to-point race which was sponsored by Vincent Bendix founder and president of the Bendix Corporation. Mantz had the aeroplane stripped of all military and other unnecessary equipment and had the Mustang's wings modified so that each wing was, in essence, a giant fuel tank, called a "wet wing". Because the Bendix Trophy was a very long-distance race typically from the Los Angeles area to Cleveland, Ohio, maximum fuel capacity was essential to reduce the number of fuel stops. The "wet wing" also meant that no external fuel tanks were required for extending range, thus eliminating their drag.

Numerous other tweaks and modifications were done to the Mustang's airframe and engine in order to extract every ounce of performance. Mantz and his team created what soon proved to be a successful formula for racing. Blaze of Noon won first prize in the Bendix Trophy race of 1946 averaging 435.50 m. p. h., again in 1947 averaging 460.42 m. p. h., and yet again in 1948, averaging 447.98 m. p. h. As competitors caught onto and began to incorporate the Mantz team's methods, they now were able to enter their own highly competitive aeroplanes. A victim of its own brilliant innovations and success, Blaze of Noon placed second to Joe DeBona's highly modified F-51D averaging a blistering 470.14 m. p. h. in the last modified military piston-engine Bendix Trophy race of that era in 1949.

However, not content to merely win and place in this prestigious air race, in 1947 the always competitive and valiant Mantz set the coast-to-coast speed record across the United States. When modified military piston-engine air racing was banned after the 1949 season, Mantz sold Blaze of Noon to actress Maureen O'Hara's soon-to- be husband, pilot Charles Blair, Jr., who renamed the aeroplane "Excalibur III", Blair went on to set a number of remarkable world flight records in it, including the 3,460 mi/5,568 km New York - to - London record in 1951 which was flown in only in 7 hours/ 48 minutes at an average speed of 443.59 miles per hour. I suspect that Blair encountered some pretty hefty and fortuitous tail winds over the Atlantic; however, it is still a remarkable feat.

Not satisfied with this, a few months later Blair flew Excalibur III from Norway to Fairbanks, Alaska, over the North Pole, a total distance of 3,130 mi/5,037 km. This flight was significant because it was thought at the time that flights over the North Pole were not safe or feasible due to the magnetic anomalies at and near the pole which greatly interfered with navigation. (Riddle-Where on earth can you stand where all directions away from you are south?) Blair successfully utilized a navigation method which incorporated sighting the sun when his compasses became useless in the polar region. For this brave feat he won the 1951 Harmon Trophy. All in the world's aviation community took notice of Blair's flight, but none more so than the U.S. Air Force's Air Defense Command (ADC). Now realizing that by similar methods to Blair's a potential air attack upon the U.S. over the Pole by the Soviet Union was possible, ADC changed their entire defense structure to accommodate such a possibility.

Excalibur III is currently on display in the National Air and Space Museum's companion facility at the Steven F. Udvar-Hazy Center near Washington Dulles International Airport where it can be seen along with such notable aircraft as the Lockheed SR-71 Blackbird, the fastest jet aircraft in the world; the Boeing Dash 80, the prototype of the venerable 707 airliner, and the historic Boeing B-29 Superfortress "Enola Gay" which dropped the first Atomic Bomb on Japan on 6 August 1945.

After W.W. II, the P-51D and H were selected by the Army Air Force to be its "standard" piston engine fighters. While other W. W. II - era fighter aircraft remained in the A. A. F.'s inventory for a while, they were gradually mustered out and sent to the knackers for scrap. From 1945 to the advent of the United States Air Force (U. S. A. F.) as an independent military service on 18 September 1947, the P-51H, actually an entirely new design that only appeared to be somewhat similar to the P-51D and which was lighter and offered greater performance than the "D" model, was beginning to come into limited service. However, it was the old, familiar "D" model that continued to be the gold standard piston-engine aeroplane for the A. A. F. Nascent jet fighters, initially P-80 "Shooting Star" and P-84 "Thunderjet" in the late '40s, and in the early '50s the fabulous F-86 "Sabre" entirely eclipsed the P-51 and all piston engine fighters. Ever since the appearance of the innovative and deadly Messerschmitt 262 jet fighter in the waning years of W.W. II the writing was clearly on the wall that the end of the era of piston-powered first-line fighter aircraft was nigh. Greatly aided and informed by brilliant German aeronautical engineers who had toiled for the benefit of the recently vanquished Nazi regime and who now worked for the U.S. (and the Soviet Union), jet aircraft technology rap-

Pail Mantz in "Blaze of Noon", formerly a P-51C.

Excalibur III P-51C-10-NT (44-10947)

idly advanced during the post-war years. As the new aviation age rapidly spooled up the A. A. F. gradually began to replace its groups' and squadrons' piston- engine powered aircraft with jet powered aircraft, reducing and relegating the role of the P-51 to advanced training and other non-strategic duties.

In 1948, the newly minted U. S. A. F. changed the designation of all fighter aircraft in its inventory from P for "pursuit", to F for "fighter"; and so the P-51 became the F-51. Many variants of the Mustang were then created including the F-6 reconnaissance series, the F-51B, D, H and K, the RF-51D (formerly F-6D), RF-51K (formerly F-6K), and at long last a two-seat trainer conversion of the F-6D, the TRF-51D. As their perceived usefulness in first-line duty lessened, these aeroplanes primarily served in the various States' Air National Guards (ANG) as well as in the Air Force Reserve (AFRES) throughout the early to middle 1950s. However, at the outset of the Korean War on 25 June 1950 the Mustang was once again called upon to serve and thus began its second combat life. The U. S. A. F. sent F-51Ds (curiously not the much faster and overall better performing "H" model) to serve in the Republic of Korea Air Force (ROKAF) as well as in U.S. A. F. units while the jet fighters which would soon take over first-line duties were being prepared.

As a short personal aside, I remember seeing what might have been a NYANG F-51H parked between two rows of hangers at the Floyd Bennett Air Base in Brooklyn, New York in 1953, sparkling brightly in the sun as we drove south on Flatbush Avenue past the airfield on our way to the Marine Parkway Bridge from central Brooklyn. Even then it looked quaint and belonging to another, now- past era.

In the less complex and certainly more relaxed era of the 1950's it was still possible for a civilian to own and fly what had recently been one of the Air Force's first-line fighter aeroplanes such as the F-51. After many spectacularly successful and extraordinarily satisfactory terms of service in all theatres of operation throughout the world in both war and peace, the U. S. A. F. finally retired its F-51s and derivatives in November 1956. The last operational Air Force Mustang is F-51D-30-NA AF Serial No. 44-74936, whose last gallant post was service in the West Virginia Air National Guard. Upon retirement it was placed in exhibit in the Air Force Central Museum as it was then called, and is currently on display at the National Museum of the United States Air Force, Wright-Patterson AFB, in Dayton, Ohio as P-51D-15-NA Serial No. 44-15174. It is painted in the colours of the P-51D flown by Col. C.L. Sluder, commander of the 325th Fighter Group in Italy in 1944. Its name, Shimmy IV, came from combining the names of Zimmy, his wife, and of Sharon, his daughter. Its last flight for the Air Force actually took place seven months after it was officially retired on 6 May 1957 when it took part in the celebration of the Air Force's 50th Anniversary which was held at the Air Proving Ground, Eglin AFB, Florida, and flew in the Aerial Firepower Demonstration.

When the Air Force withdrew the Mustang from its inventory in 1956, well over a thousand of them were suddenly made available on the civilian market. Thus came the second and last opportunity for the public to purchase a Mustang directly from the Air Force. Unlike the knackered, war- torn surplus P-51s, mostly ready for the scrap yard that were made available to the public immediately after W.W. II as described above, many of these Mustangs were in very fine condition, a good number of them having recently been in daily service and which had been regularly maintained and diligently cared for by Air Force ground-crews and mechanics.

Of course, not all or possibly even a great many of these ex-Air Force Mustangs were in pristine or even very good condition. However, some of those which were truly worn out and which had been cast aside to be scraped were rescued from that inglorious fate and were purchased at greatly reduced prices to eventually be rebuilt and restored. Unfortunately, despite their bargain prices, the P-51's enormous maintenance and operating costs have always made owning and operating them prohibitive for all but the wealthiest individuals and organizations. Accordingly, a relative few Mustangs which were made available to the public in 1956 were purchased, and sadly all too many precious Mustangs, many in fairly good condition, as in 1945-6, once again went to the scrap yard and were lost forever. Accordingly, out of the approximately 15,496 Mustangs of all types that have been built, only approximately 70 Mustangs exist in flyable condition today.

While few individual civilians could afford to purchase and maintain a surplus F-51 for sport in 1956; in 1964 and after when modified military piston- engine air racing was once again permitted, air racing teams picked through the surviving civilian P-51s and selected the best candidates for racing. Unofficially designated P-51R, the Mustang has always been popular in racing circles for one reason — they go fast.

As in years past, modern racers often select the P-51 as their mount of choice. The choice of the P-51 has often been rewarded with victories, trophies and broken records for piston aircraft as exemplified by "Dago Red", a much modified P-51D, which has flown tight- turning pylon races at the incredible average speed of 500 m. p. h.

An apt description of the P-51 is "sleek". The small frontal profile of the Mustang's fuselage, its laminar airfoil, the use extensive of flush riveting, its still sophisticated, low drag/high thrust radiator intake/exhaust design, its simple, low-tech construction and materials, and the high power-to-weight ratio of a standard, unmodified Mustang makes it an ideal competitor even in its stock condition. Additionally, the uninterrupted and continuing availability of replacement and spare parts for both the airframe and the engine makes it feasible and reasonably practical to keep these aeroplanes running even when pushed to and often well- beyond their published factory limits.

Another feature of the Mustang that appeals to those who wish to race them is that they are easily modified. The records show that the P-51B is the fastest of the W.W. II Mustangs. The primary reason for this in addition to its superb Merlin 61, V-1650-3 engine is that its rear fuselage fairs directly from the canopy to the vertical fin, producing a smooth uninterrupted path for the air to travel. The P-51D was powered by essentially the same engine; however, a major P-51D design feature is the bubble or tear-drop canopy and the cut-down rear fuselage which was introduced to enhance the combat pilot's rearward vision. While the new bubble canopy accomplished this, the turbulent vortex produced by the D's now protruding canopy added a good deal of additional drag, and the cut down rear fuselage made the initial batch of these aeroplanes slightly unstable in yaw at high speeds. Accordingly, a triangular dorsal fin was soon added to the vertical fin which restored some of the side area which had been removed when the rear of the fuselage was cut down.

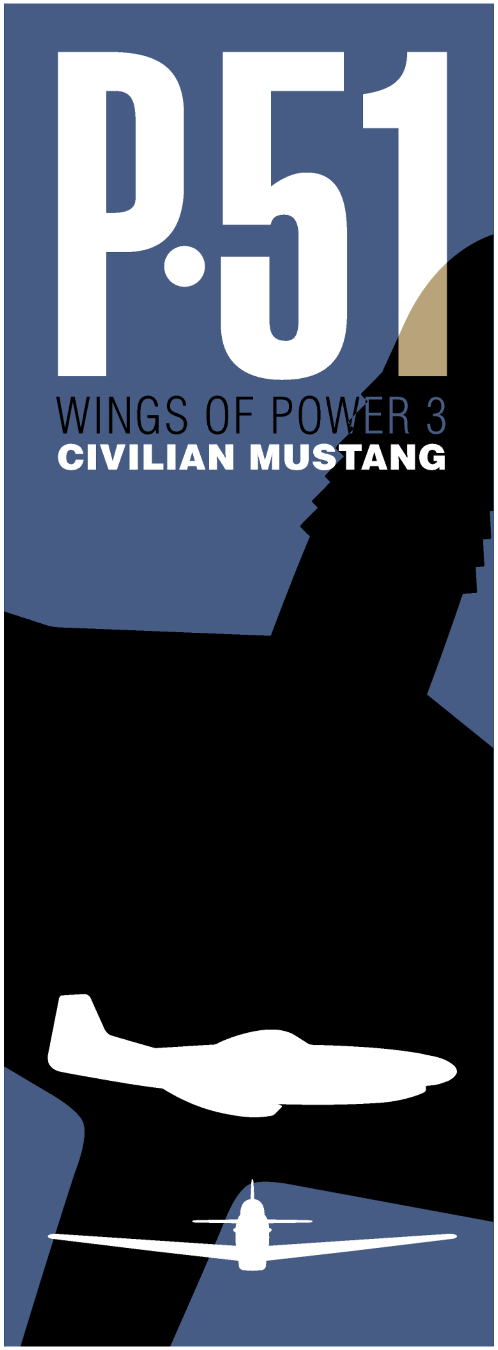
Many racing teams who seek to minimize the P-51's airframe's drag in order to squeeze every drop of speed from the aeroplane and to maximize the airframe's already high efficiency, initially removed the dorsal fin and restored the old-style model B "razorback" rear fuselage on many racing P-51s. This did give them a few extra miles per hour; however, as it turned out, some rear visibility was a benefit even to the racing pilot who needs to be able to see the aeroplanes behind during the race. Accordingly, semi-bubble canopies, all radically cut down from the original design in order to minimize drag have been installed in many P-51 racers.

Racers also clipped the Mustang's wings, an easy and convenient alteration as there is a convenient break in the wing's structure in just the right place. The ailerons were shortened in span as well and one of three hinges was removed. The three landing gear doors (2 main, 1 tail) were made more flush, eliminating a source of much drag. Additional fairings at the juncture of the fuselage and the wing and tail surfaces were installed and flush rivets replaced the old raised dome- style rivets.

The P-51's fuselage tank was a perfect place for anti-detonation fluid (ADI), usually a 60/40 mix of water/methanol which, when injected into the fuel stream, boosts the engine's performance. Methanol, which is wood alcohol, when added to the gasoline adds BTU's to the fuel mix which in turn permits higher manifold pressures. However, the addition of methanol to gasoline also lowers the mixture's freezing point to as low as -40C and lowers the boiling point as well. The lower freezing/boiling point of fuel can cause vapour lock within the fuel system, hence the addition of water, which raises the mixture's freezing/boiling point while still allowing the methanol to provide extra manifold pressure boost to the engine.

Over the years, millions of people have been, and will surely continue to be entertained, thrilled and impressed by P-51s flown at air shows, warbird gatherings and historical fly-bys all around the world. This is a fine and deserved legacy for the legendary P-51 Mustang, considered by many to be the greatest piston-engine fighter aeroplane of all time.

Mitchell Glicksman



1 Introduction

Designer's Notes:

The release of the new "Civilian Mustang" marks an important milestone for A2A. Our roots have been in both general aviation and military aviation history, and A2A has used this passion and experience to bring many Warbirds to Microsoft Flight Simulator X. However, this release does our best job combining these two worlds.

At the break out of World War II, the skies were filled with aircraft developed in the mid to late 1930's. Aircraft were still transitioning from fabric to all-metal designs, and for the most part, automatic systems management really did not exist. The height of single-engine complexity would be the P-47 Thunderbolt, which had a plethora of systems to manage (manual cowl, cooling, and oil flaps, manual turbo, manual throttle management, etc.). The pilot was being taxed to just fly the aircraft, let alone engage an enemy or avoid being attacked. Over the course of the war, aircraft were made ever more aerodynamic, engine power was pushed to its limit, and systems were gradually made to work automatically. The P-51 Mustang represents the very pinnacle of this wartime development, and today hundreds of P-51's fly in a modern world and perform not just adequately, but admirably. The P-51 Mustang today is an outstanding, all weather cross-country platform. It is considerably faster and can fly further than the fast majority of general aviation aircraft, and is just shy of the speed of a personal jet. While maintaining a real Mustang is hobby for the wealthy few, Mustang pilots today regard their aircraft as sturdy and reliable.

During the development of the Accu-Sim Mustang over the years, we have taken four test flights in two different Mustangs flying today. The cockpit we designed in this Civilian Mustang was designed over many months with the assistance of Mustang pilots, owners, and our own in-house staff.

Owning and operating a Mustang today is a dream to many, and this is what we believe flight simulation is all about.

Make your dreams come true.

The Air to Air Simulations Team

Welcome to the Cockpit of Your Modern Mustang

The P-51D Mustang is a high performance propeller driven aircraft. A2A Simulations realized that there was a market for offering a modernized version of this popular aircraft for aviation enthusiasts. Your aircraft has been fitted with relatively modern equipment to provide you with an excellent platform for a multitude of aviation purposes not previously attainable in the military equivalent. With this new set of instrumentation and equipment you now have a high speed powerful prop aircraft able to perform and compete in the general aviation field. With the addition of the Century III autopilot system you now have a set of extra mechanical hands to assist you while flying in most weather conditions. A classic warbird is now IFR capable. This aircraft represents what a pilot or observer may find in most Mustangs at airshows today. It should be noted that such an aircraft should not be flown into known icing conditions as no further icing equipment has been installed. During the creation process several high hour pilots were asked what they would like to see in addition to what had already been created on our modern variation. From these discussions we found a common cadence of functionality. As a result, some instrumentation has been moved, altered and altogether replaced along with additional instrumentation that provides the pilot better feedback about the state of their aircraft. It is believed that we have created a very unique environment that caters to most pilots that has never been experienced before in Flight Simulator. We hope that you, the customer agree, that this aircraft represents the pinnacle marriage of a classic aircraft with the often necessary equipment needed to successfully navigate today's rigorous flight environments while offering a feel of authenticity that can only be achieved through the meticulous work that went into this product and the associated Accu-Sim line of aircraft. Congratulations on your new purchase!!

Some Differences between the Modern Mustang & the Military Mustang

- The removal of the six Browning M2 machine guns. The gun ports are still visible for aesthetic purposes. This will bring the center of gravity slightly forward from the military variant.
- Removal of radio wire that runs from tail to canopy. Although often removed during wartime as well, this system has no place in the modern cockpit Mustang and thus has been removed.
- Removal and replacement of older radio and navigation equipment which offer a higher degree of reliability, are easier to use and have reduced weight.
- Removal of AN/APS-13 airborne tail warning radar and associated equipment in the tail as well as inside the cockpit.
- Interior cockpit is now gray which reflects USAF and reserve Mustangs and is found in many restored aircraft to this day.
- Removal of K-14a gunsight, mounting bracket as well as associated equipment such as the target range cable attached to the throttle.
- Pilot helmet changed from standard USAAF equipment to the safer and more often found modern day equivalent, the HGU-71/P and oxygen mask.
- Addition of Garmin global position system mounted where the K-14a originally was.
- Removal of IFF equipment
- Addition of Century III autopilot and lateral guidance system.
- Addition and removal of various gauges to provide the pilot additional tools for navigation and aircraft status.
- Addition of rotating beacon to the underside of the fuselage.

Century III Autopilot

Century III Autopilot and Lateral Guidance System

The Century III is a light weight autopilot offering maximum performance and utility. The system can compensate for unbalanced fuel loads and incorrect trimming as well as power changes making it an ideal autopilot for the P-51D Mustang. Please note that only pitch trim is adjusted with this autopilot system and not aileron or rudder trim however turns made with the system are coordinated. The simulation closely mimics the unique features of this autopilot system. It is suggested to read the following information before engaging the autopilot.

Roll Switch (Aileron)

The roll function acts as a master switch for the autopilot. When engaged (up) by itself the autopilot responds only to the attitude gyro as well as the built in console roll command knob. When the roll command knob is neutral with the roll switch engaged, the system will automatically level the wings. Note this function does not command the pitch of the aircraft.

Heading Switch

The heading switch (labeled HDG) disengages the roll command knob circuit. The unit is coupled with the horizontal situation indicator (HSI) and its heading bug/course selector. Before engaging the heading switch the heading bug/course selector should be set to the desired heading. The unit is capable of turns up to 180 degrees and will turn into the direction most efficient to the desired heading. For more information on how to utilize the horizontal situation indicator (HSI) and the heading bug/course selector please see the appropriate section.

Altitude Hold Switch

The altitude hold switch (labeled ALT) requires no pitch adjustment prior to activation. Upon engaging the altitude hold switch (up) the system will remove the pitch switch and its associated pitch wheel from the circuit. Once commanded the autopilot will conduct a smooth transition to the pressure altitude at which the switch was engaged. Once the altitude has been reached the system will maintain pitch of the aircraft to maintain the desired pressure altitude.

Pitch Switch (Elevator)

The pitch mode switch activates the autopilot pitch command wheel and controls the aircraft based upon the position of the pitch in cooperation with the gyro horizon. When activated (up) the system will compensate for power adjustments to maintain the desired pitch directed with the pitch command wheel.

Roll Command Knob

This knob controls the axis of the aircraft permitting turns up to 30 degrees when the roll switch is engaged. It is useful when making adjustments in heading with the roll switch activated. When heading mode is engaged (HDG) the position of the roll command knob is ignored. Before engaging the autopilot or when not in use it is suggested to keep the knob centered.

Pitch Command Wheel

The pitch command wheel controls the aircraft to the desired pitch when the pitch switch is activated. It is suggested to adjust the pitch wheel to the desired attitude before engaging the pitch switch. In conjunction with the trim indicator located on the Century III unit you can determine how the aircraft will react once engaged. See trim indicator below for more information of how to utilize the pitch wheel properly.

Pitch Window

This window indicates where the pitch command wheel is in relation to the attitude of the aircraft. If for example the pitch window shows a higher attitude then upon engagement of the pitch switch the attitude of the aircraft will increase until centered. If the indicator shows a lower pitch then upon engagement the aircraft's attitude will decrease until centered. It is advised to center the pitch trim wheel in conjunction with the pitch window prior to engaging the pitch switch to smoothly transition from your current attitude to the autopilot controlled system. If transitioning from altitude hold to a pitch hold (both pitch and altitude switches up and engaged) you can set the desired pitch for smoother operation. Remember that with both switches engaged the autopilot upon releasing the altitude hold will command the aircraft to the desired pitch as viewed from the pitch window. As a safety precaution it is recommended to set neutral attitude pitch in the pitch window via the pitch command wheel unless an attitude change is desired after disabling altitude hold (altitude switch). Further, upon activating the pitch switch by itself it is further advised to set the pitch command wheel in reference to the pitch window so that operation is smooth and to avoid unnecessary or dangerous pitch changes.

Century III Engagement Sequence:

1. Trim aircraft to desired attitude with standard trim systems.
2. Center roll knob and engage the roll switch (into up position).
3. Center heading bug/course selector on the horizontal situation indicator to your current heading.
4. Center the trim indicator in the trim window on the autopilot console with the pitch command wheel and engage pitch mode (pitch switch up).
5. Engage altitude hold switch (up) at desired altitude.

Century Lateral Guidance System

The Century lateral guidance systems allows tracking via the autopilot for navigational purposes. This system allows the autopilot system to automatically intercept and track at the pilot's desire. The system is comprised of five operational modes. In order to utilize the lateral guidance system the autopilot must be in heading mode (heading switch up).

Omni Mode

While in OMNI mode the system is coupled to the HSI (horizontal situation indicator). By setting the heading bug indicator to the desired course indicator all headings will then be controlled by the omni radio signals. A full deflection on the indicator (10 or more degrees off selected radial) will produce a 45 degree interception angle. Inside 10 degrees the system will automatically compute the location and closure rate to provide a smooth transition to intercept. The same intercept will be accomplished in anything over 2 miles out to maximum reception from station. Under 2 miles the aircraft bank limitations will allow a small overshoot when making maximum angle interception.

NAV Mode

NAV mode is designed to extend the coupler utility by making operation practical under adverse conditions. There is a small time delay in the circuit which reduces reaction to short term needle deflections. Close in OMNI approach work requires the the dynamic response of OMNI mode so there for NAV mode should not be used when close to a station.

Heading Mode

While in heading mode, the autopilot will function as previously described. This is the standard operation mode and it is advised to leave the system in heading mode when not in use.

Localizer Mode

In LOC NORM mode the system automatically adjusts it's sensitivity to accommodate the 2.5 degrees of full needle deflection instead of the 10 degrees as found in OMNI navigation. Intercept angles of 45 degrees are still automatic with full signal deflection. The system also compensates automatically for crosswinds. As with OMNI mode the course selection indicator must be set to the desired magnetic track.

Localizer Reverse Mode

The lateral guidance system is equipped with a localizer reverse feature allows automatic back course approaches and tracking outbound prior to a procedural turn. The features of localizer reverse mode are similar to those of the localizer mode except that the aircraft will fly away from the localizer needle instead of towards it. The course selection indicator must be set to the reciprocal heading, so if the localizer is at 90 degrees you would want to set the desired course to 180 degrees.

A few important notes about the Century III Autopilot:

- LOC NORM must be selected for 20 seconds before the Localizer capture circuit is armed.
- LOC NORM must be selected for 20 seconds before Glideslope capture circuit is armed.
- The Altitude switch must also be depressed in the ALT position at least 20 seconds before the Glideslope capture circuit is armed.
- The Glideslope Deviation Indicator must be deflected upward for at least 20 seconds before the Glideslope capture circuit is armed.

VHF Communications

Your aircraft has been supplied with a KFS 598 VHF radio. This radio represents COM1 respectively.

ON/OFF/VOL

This small switch on the unit turns the radio on and off. It is recommended to have the unit(s) off prior to turning on or off the master avionics switch in the aircraft.

Active And Standby Window

This window indicates the current active frequency and the standby frequency. The active frequency is located at the top of the window while the standby frequency is located at the bottom. When adjusting frequencies, only the standby frequency will be changed for your convenience so as you are able to transmit and receive on the current frequency. If the radio is selected for transmit, a TX (transmit) label will be located to the right of the active frequency. The standby frequency will be labeled with a STBY located to the right as well.

Transfer Button

To the lower right of the active and standby window is a small transfer button. This will allow you to switch the active and standby frequency so as you may change your current or proposed transmit frequency.

Frequency Control Knobs

This is the control knob for changing your standby (STBY) frequency. The larger knob controls the radio at 1MHz steps while the smaller inner knob controls 50KHz intervals. You may use the mouse wheel for easier tuning. For your convenience you can also place the mouse over the standby (STBY) frequency on the active and standby window, utilizing your mouse wheel to change frequencies. You can further select channels by the use of the control knobs for both programming purposes and for selection of preset frequencies.

Active Entry Mode

Active Entry Mode is a quick way to change the active frequency without utilizing the standby entry method described above. To enter Active Entry Mode press and hold the Transfer button for more than two seconds. The frequency displayed in the Active window can then be changed using the Frequency Control Knobs. The unit will be tuned to the frequency displayed in the Active Window at all times. Momentarily pressing the Transfer button will return the unit to Standby Entry Mode.

Chan Button

The channel button allows pilots to program and store frequencies. The button operates in two different modes described as channel mode and program mode. When you momentarily press the channel button the unit will be set in channel mode. The last channel is displayed on the unit unless none has been programmed, in which case the unit will default to Channel 1 with dashes displayed in the standby (STBY) window. Turning either frequency control knob will select a channel as long as they have been programmed. To select a programmed channel frequency you simply select the channel and it becomes the active frequency without further operator interaction.

Note that programmed channels are stored and saved between flying sessions.

NAV/VOR/ILS

Your aircraft has been supplied with a KFS 564A navigation unit. This unit represents NAV1 respectively. This unit looks and operates similarly to the KF 598 radio.

ON/OFF/VOL

This small switch on the unit turns the radio on and off. It is recommended to have the unit(s) off prior to turning on or off the master avionics switch in the aircraft.

Active And Standby Window

This window indicates the current active frequency and the standby frequency. The active frequency is located at the top of the window while the standby frequency is located at the bottom. When adjusting frequencies, only the standby frequency will be changed for your convenience so as you are able to receive on the current frequency. The standby frequency will be labeled with a STBY located to the right.

Transfer Button

To the lower right of the active and standby window is a small transfer button. This will allow you to switch the active and standby frequency so as you may change your current or proposed receive frequency.

Frequency Control Knobs

This is the control knob for changing your standby (STBY) frequency. The larger knob controls the radio at 1MHz steps while the smaller inner knob controls 50KHz intervals. You may use the mouse wheel for easier tuning. For your convenience you can also place the mouse over the standby (STBY) frequency on the active and standby window, utilizing your mouse wheel to change frequencies. You can further select channels by the use of the control knobs for both programming purposes and for selection of preset frequencies.

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Note that programmed channels are stored and saved between flying sessions.

ADF

Your aircraft has been supplied with a KFS 586A navigation unit. This unit represents the ADF respectively. This unit looks and operates similarly to the KF 598 radio.

ON/OFF/VOL

This small switch on the unit turns the radio on and off. It is recommended to have the unit(s) off prior to turning on or off the master avionics switch in the aircraft.

Active And Standby Window

This window indicates the current active frequency and the standby frequency. The active frequency is located at the top of the window while the standby frequency is located at the bottom. When adjusting frequencies, only the standby frequency will be changed for your convenience so as you are able to receive on the current frequency. The standby frequency will be labeled with a STBY located to the right.

TRANSFER BUTTON

To the lower right of the active and standby window is a small transfer button. This will allow you to switch the active and standby frequency so as you may change your current or proposed receive frequency.

FREQUENCY CONTROL KNOBS

This is the control knob for changing your standby (STBY) frequency. The larger knob controls the radio at 100KHz steps while the smaller inner knob controls 10KHz intervals. You may use the mouse wheel for easier tuning. For your convenience you can also place the mouse over the standby (STBY) frequency on the active and standby window, utilizing your mouse wheel to change frequencies. You can further select channels by the use of the control knobs for both programming purposes and for selection of preset frequencies.

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Note that programmed channels are stored and saved between flying sessions.

Transponder

Your aircraft has been supplied with a KFS 576A navigation unit. This unit represents XPDR respectively. This unit looks and operates similarly to the KF 598 radio.

ON/OFF

This small switch on the unit turns the radio on and off. It is recommended to have the unit(s) off prior to turning on or off the master avionics switch in the aircraft.

Active Window

This window indicates the current active transponder code as well as other numerous codes described below to communicate to the pilot the current state of the transponder and its operating modes.

Reply Indicator

Located in the upper left portion of the active window. During normal operation this indicator will be present to indicate a transmitted reply. It is represented by R.

Flight Level Indicator

Located on the left side of the active window below the reply indicator,this readout shows the indicated flight level when desired. It is represented by FL. When active the code in the active window will show current altitude flight level in 100 foot increments. A readout of 005 would represent 500 feet. A readout of 055 would represent 5,500 feet. A readoutof 555 would represent 55,500 feet.

SBY/ON/ALT/IDT indicators

These indicators show the current mode that the transponder is in; Standby (SBY), On (ON), Altitude (ALT) and Identification (IDT).

IDENT Button

When depressed sends an identification reply for aproximately 25 seconds. During operation the identification (IDT) indicator will illuminate.

Function Selector Knob

This is the outer control knob which is used to operate the different modes of the transponder.

SBY

When selected to SBY (standby) mode, the unit will be put in an external standby mode. It will not broadcast or receive signals in this mode and must be moved from this position to operate the unit.

ON

When selected to ON the transponder replies to both Mode A and Mode C interrogations. This is the default operation mode of the transponder.

ALT

With the selector placed in the ALT position (altitude) the transponder will automatically select the proper reply mode in either Mode A or Mode C while transmitting altitude information.

TEST

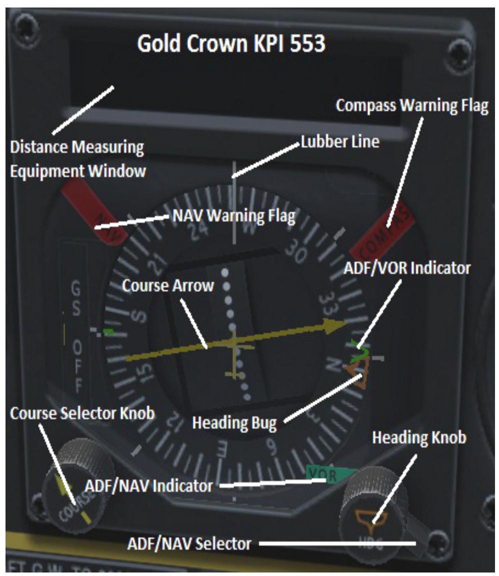
When the selector is placed in the TEST position the unit provides for a preflight or airborne check of transponder operation. In this position the R (reply indicator) to flash or light continuously. Further, while in this mode the FL (flight level) indicator will illuminate and display the current flight altitude.

Code Selector Knob

Pressing the code selector knob changes the cursor for the transponder code which is indicated by an arrow under the desired number. By rotating the selector knob you can change the code within the selector cursor.

Horizontal Situation Indicator

One of the most important instruments in your cockpit for navigation is the KPI



553 HSI. The horizontal situation indicator located in your P-51D serves multiple functions for navigation and situational awareness. The unit is tied directly to your Century III autopilot for ease of operation as well as your navigation radios. Lastly the unit has a built in distance measuring equipment to supplement your flight planning.

Lubber Line

A fixed reference mark indicating the nose of your aircraft.

Heading Bug

An orange line that indicates your desired heading. Used in conjunction with the heading knob. See Heading Knob and Heading Bug/Course Selector below.

To/From Indicator

Indicates whether the course pointer is showing the magnetic bearing to or from the station.

Heading Knob

The heading knob, located in the lower right corner of your HSI serves two primary functions. First is to provide a reference bug for course changes or otherwise but second to command the heading move of your Century III autopilot. When the heading switch is engaged with the lateral guidance system set to HDG your autopilot will track the desired heading on the heading bug (orange arrow). You can adjust this bug by clicking and moving your mouse over the heading knob (marked HDG with the appropriate bug symbol). You can make further refined movements by rotating the mouse wheel with the cursor placed over the knob.

ADF/NAV Selector
Rotating this lever determines which information (ADF or NAV) is being displayed. Upon selection the NAV or ADF indicator will show confirming your selection.

ADF/NAV Indicator
A green indicator that shows bearing to the current selected ADF or NAV signal.

Course Selector Knob
Positions the course selector on the compass card.

Glideslope Deviation Indicator
Indicates glideslope beam center with respect to aircraft's location. Glideslope scale is +/- .35 degrees per dot. A black glideslope warning flag covers this area when the glideslope signal is invalid.

Compass Card
Indicators the aircraft's magnetic heading with reference against the lubber line.

Compass Warning Flag
This red warning flag appears when there is a power failure or a compass card servo failure occurs.

NAV Warning Flag
The red warning flag appears when the navigational receiver is invalid.

Course Arrow
This yellow indicator displays the selected course.

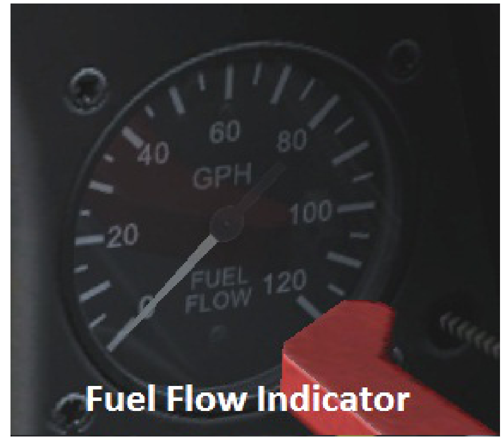
Lateral Deviation Indicator
Indicates flight on selected VOR radial, localizer beam or R NAV track with respect to the aircraft's location. 1 dot equals +/- 5 degrees of localizer deviation, +/-2 of VOR deviation, +/- 1 mile RNAV en route deviation and +/- 0.25 mile RNAV approach deviation.

Distance Measuring Equipment
The KPI 553 is equipped with distance measuring equipment displayed at the top of the unit. The left of the display shows nautical miles (marked NM) to the VOR as determined by the function switch. The middle of the display shows ground speed in knots, (marked KT). Not that this ground speed is only accurate when flying direct to or from an avigational device. At the right of the display is minutes to the station (marked MIN). This shows an approximation based on ground speed and distance of how long it will take to intercept the station when flying directly to it.

Other Gauges and Controls

Coolant Door Indicator:
Unlike the production aircraft that were sent from North American Aviation to the military, your aircraft has been equipped with a coolant door indicator gauge. This indicator provides readouts for both of your cooling doors located on the bottom of the fuselage. This indicator provides easy feedback for knowing their position which is especially helpful when the engine is running and you cannot hear the coolant door motors.

Fuel Flow Indicator
Another upgrade from a standard Mustang, your aircraft has been equipped with an instrument that measures the fuel flow of the aircraft in gallons per an hour (GPH). You will find this instrument useful for in flight



Fuel Flow Indicator

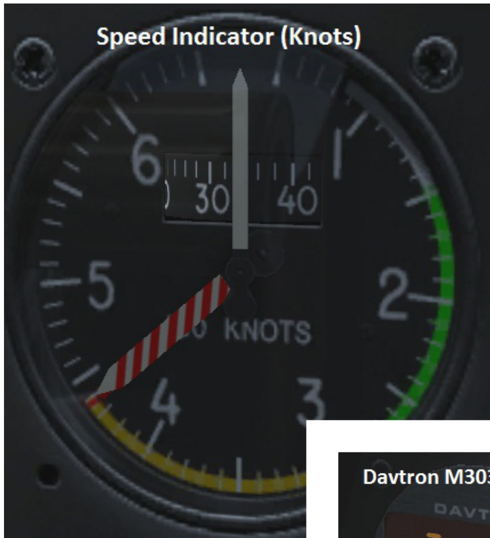
planning and fuel consumption and can be useful for troubleshooting engine problems.

Magneto Switch
The magneto switch on your modern P-51 is of a key type. It has been located on the same panel as your starter switch for ease of use.

Audio Switch Panel
Located below your HSI and vertical speed indicator is an audio switch panel. Each switch corresponds to the audio channel for the purpose of communication and navigation station identification including OMI markers. The switches labeled in yellow are microphone switches and are used to determine where your microphone is broadcasting.

Audio Switch Panel

Speed Indicator



The speed indicator of your aircraft is read in knots. A rotating indicator inside the bezel is utilized for convenience.

Oil, Fuel and Generator Warning Lights

Not initially included in factory Mustangs, these have been added to your aircraft to provide high visibility warning indicators of impending issues. The generator light will warn when the RPMs are insufficient to operate the generator and/or the generator fails. The oil light warns when your oil pressure becomes too high or low and lastly the fuel indicator light will illuminate when the contents of your selected tank become low. It is not unusual for these lights to illuminate during the warmup process due to high oil pressures or lack of engine power. They should be checked during the ground engine run-up to ensure proper function of the associated systems prior to takeoff.

Davtron Model 303 OAT Gauge

This gauge displays the outside ambient temperature in both Fahrenheit and Celsius. Additionally the system can show the current voltage drawn. To change the display simply press the small blue button on the gauge face.

Garmin GNS 400

This has been added to your aircraft to provide basic navigational data. It has been programmed with the default GPS and represents a basic GNS installation without subscriptions to some of the more elaborate features of the unit. The unit has been tied to your Century III autopilot system for lateral autopilot navigation. Inside your cockpit is a switch to change from VOR to GPS navigation which will be represented in your HSI and allows for tracking on your autopilot. Should you desire to utilize a different or more advanced unit there is an option to change the face to 2D allowing you to modify the instrument or swap it out with other payware products. All of the functions of the basic unit are provided and you can use the mouse scroll over the knobs to swap to the various pages of the unit. For more information on how to utilize the basic GPS please read the tutorials provided with Microsoft Flight Simulator X.

Standby Magnetic Compass

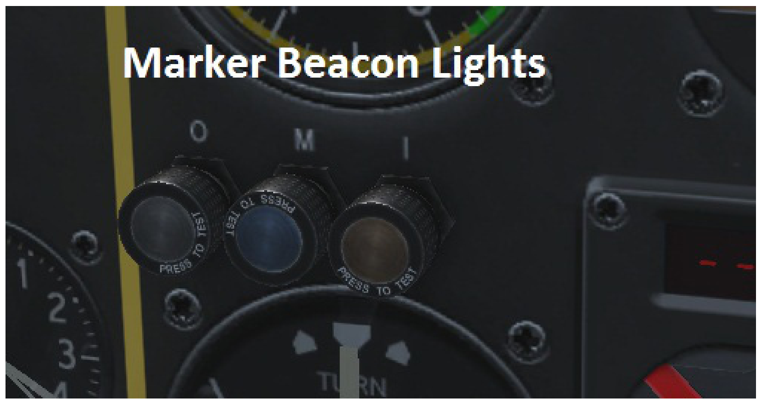
Although your HSI provides a trouble free means of navigation without requiring adjustment for gyro drift, a standby magnetic compass has been placed in your aircraft in the upper right hand side of the cockpit in case of failure.

Gear Indicator Lights

The gear indicator lights have been modified from their military counterpart to be more intuitive and easier to read. There are four lights, one for each landing gear and another which indicates the state of the entire system. When a gear indicator becomes green it indicates that the gear is down and locked. When the unsafe light is illuminated it indicates the system is still in operation or has malfunctioned. For example, if you were to takeoff, the indicator lights would show green for each individual gear while the unsafe light will not be illuminated. Upon lifting the gear handle the unsafe light will become illuminated as the fairing doors drop. As each gear moves upwards from their locked position, the individual lights (green) will turn off. Once the landing gear system has completed its cycle (all landing gear up along with fairing doors) then all indicators should be off. This shows that the gear are in the up-locks, fairing doors are closed and the system has completed its cycle. The description is reversed when lowering the gear.

Strobe, Beacon & Navigation Lights

Although present, the recognition lights are not functional and for aesthetic purposes only. The aircraft is equipped with standard red/green/white navigation lights. Further your aircraft has had a rotating beacon and strobe light affixed to the fuselage for higher visibility when operating at night or in less than ideal weather. This allows higher visibility of the aircraft as seen from other aircraft as well as the ground. The strobe light has been attached to the tail of the vertical stabilizer (tail) and pulses at a regular interval. The rotating beacon which is located underneath the intake should be on at all times while the prop is in motion.



KA51B Control & Compensator Unit:

The Horizontal Situation Indicator can work in either Slave or Free mode. In Slave mode the compass card is automatically aligned to magnetic north and constantly corrected for gyro drift. In Free mode magnetic sensor is disconnected and the unit works as directional gyro. In this mode it is possible to manually rotate the compass card. A periodic check with the standby compass is recommended to assure there is approximate agreement. In normal operation Slave mode should be used all the time.

The control and compensator unit is located between the radio units behind the stick. It consists of Slave/Free switch, CW/CCW switch for manual adjustments in free mode, and small slaving indicator which shows the difference between heading indicated by compass card and magneting heading from the sensor. Whenever the aircraft is in a turn and the card rotates, it is normal for this meter to show a full deflection to one side or the other.

Wings of Power 3: P-51 Mustang Features

- Experience one of the fastest and most powerful propeller driven aircraft in the world today
- IFR cockpit exclusively designed and built from Mustang owners and our own staff
- 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).
- 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 Microsoft Flight Simulator X. 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 FSX 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.

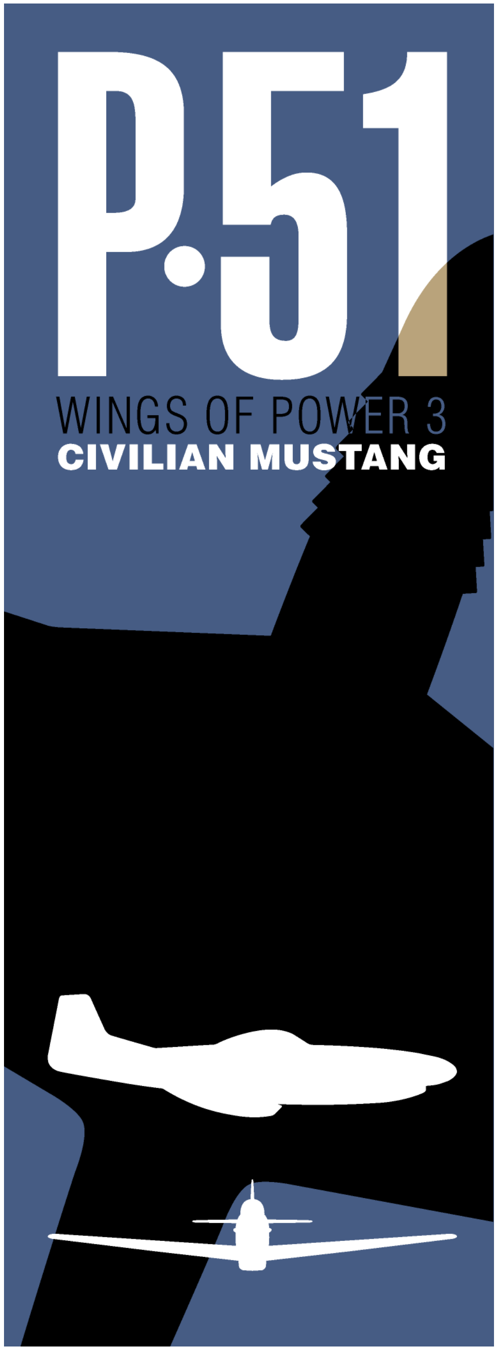
The critical altitude, for supercharged or turbocharged aircraft, is the altitude at which maximum power can no longer be maintained. For example, if your maximum power is achieved at 50" manifold pressure, then the altitude at which you can no longer achieve 50" manifold pressure is called your critical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



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 Wings of Power P-51 Mustang requires the following to run:

- REQUIRES LICENSED COPY OF MICROSOFT FLIGHT SIMULATOR X
- SERVICE PACK 2 (SP2) REQUIRED

Note: While the A2A Wings of Power P-51 Mustang may work with SP1 or earlier, many of the features may not work correctly, if at all. We cannot attest to the accuracy of the flight model or aircraft systems under such conditions, as it was built using the SP2 SDK. Only Service Pack 2 is required. The Acceleration expansion pack is fully supported but is NOT REQUIRED.

OPERATING SYSTEM:

- Windows XP SP2
- Windows Vista
- Windows 7
- Windows 8

PROCESSOR:

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

HARD DRIVE:

- 250MB of hard drive space or better

VIDEO CARD:

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

OTHER:

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

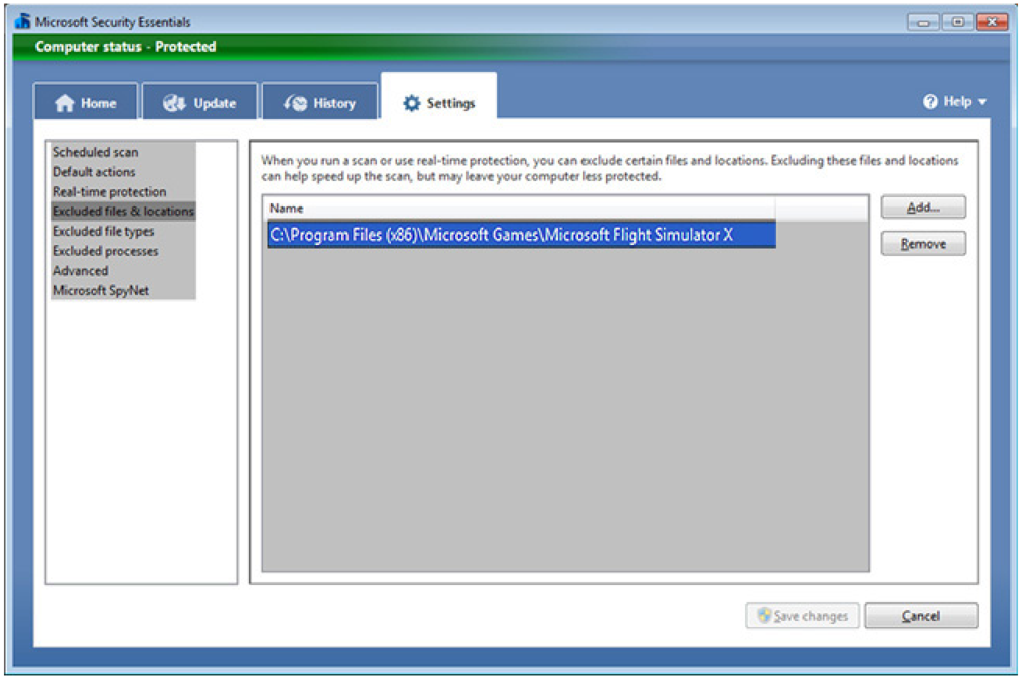
Installation

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

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

IMPORTANT:

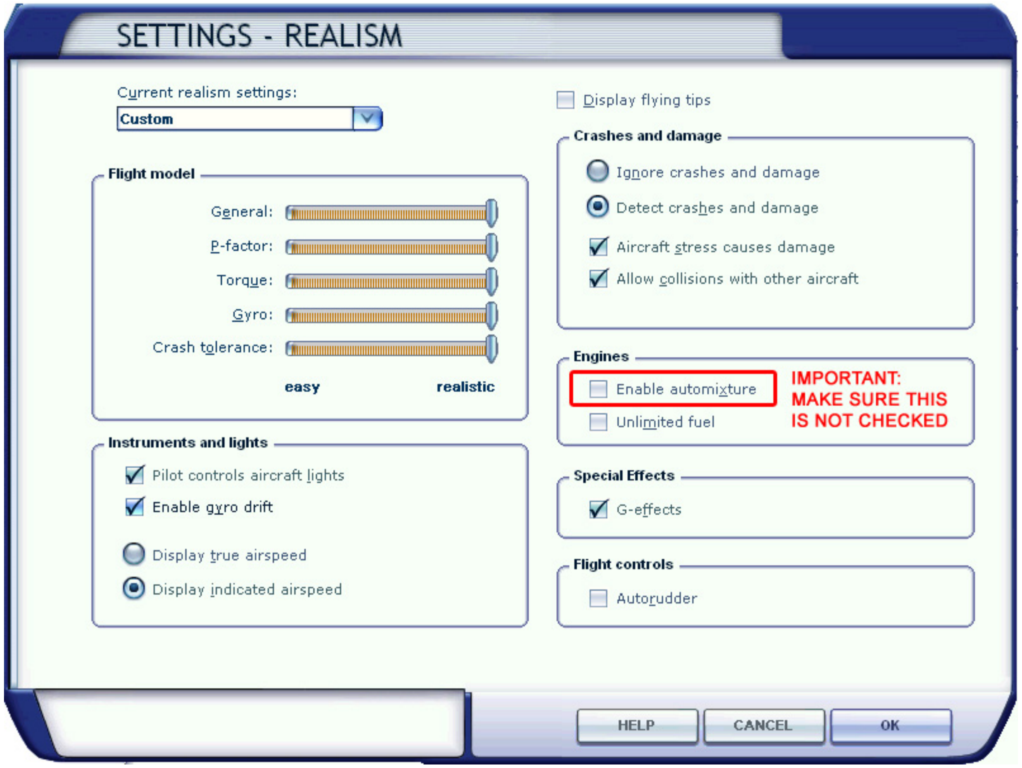
If you have Microsoft Security Essentials installed, be sure to make an exception for Microsoft Flight Simulator X as follows:



Realism Settings

The A2A Simulations Wings of Power 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 Microsoft Flight Simulator X.

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 Wings of Power 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 above. The only exception would be "Crash tolerance."

INSTRUMENTS AND LIGHTS

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

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

ENGINES

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

FLIGHT CONTROLS

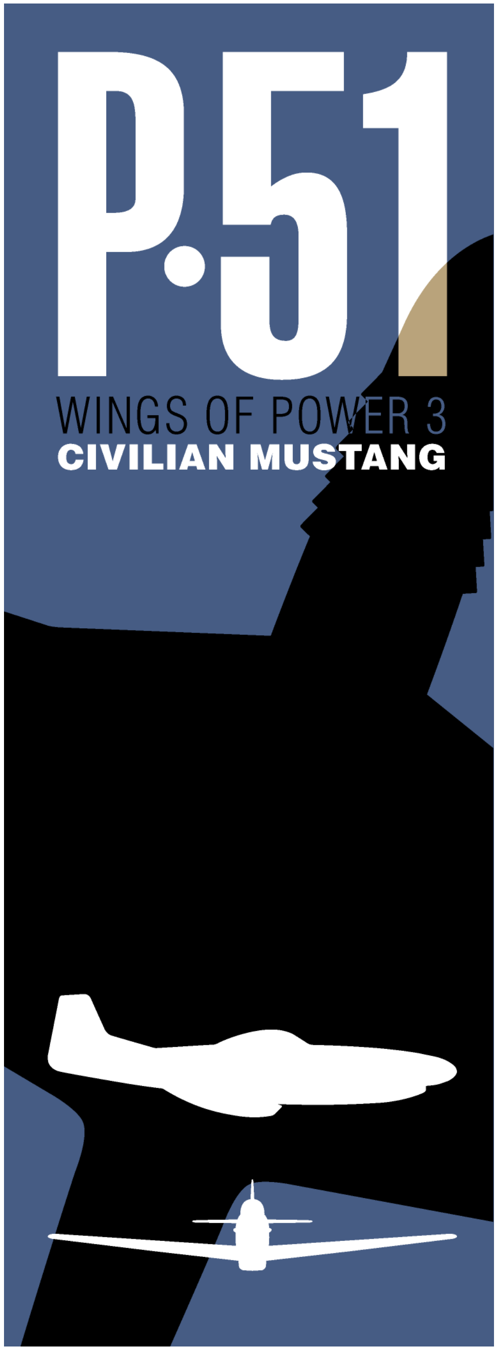
It is recommended you have "Auto-rudder" turned off if you have a means of controlling the rudder input, either via side swivel/twist on your specific joystick or rudder pedals.

ENGINE STRESS DAMAGES ENGINE

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

Quick Flying Tips

- To Change Views Press A or SHIFT + A.
- 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 The Saga of 5412Victor

By Dudley Henriques

Many of you in the flight simulation community know me from my technical tutorials that I have written through the years dealing with the flying of real life high performance airplanes and how that relates to flying them in Microsoft Flight Simulator.

I'd like to deviate from my familiar format this time, with your kind permission, to take a slightly different approach with an article and tell you a story from life… my life.

As I sit here writing this today, I am in my den at home. Surrounding me are hundreds of pictures of the people I have known and flown with and the aircraft I have flown during the fifty odd years I spent in professional aviation as both a pilot and an instructor.

I've never actually counted them all up exactly, but somebody once said I had probably flown about 50 different types of airplanes in my career ranging from the smallest experimentals on up to the hottest prop fighters including Mustangs and supersonic jets. Looking back I truly can say I loved every minute of it.! I guess if I thought about it long enough I could sit here and dig up a thousand stories to tell you about the people on our den walls, the airplanes on the den walls, and the good times and the bad times they represent to me. But strangely enough, with all this experience and all these tales and "war stories" to choose from, the story I'd like to share with you is about a special fighter plane that probably will always be closely associated with me personally but is fondly known around our family as "the Mustang Dudley never flew".

5412V was a P51D and initially came out North American Aviation's Inglewood California factory in 1944 in block 25NA and was assigned the tail number 44-73586.

With the war almost over, the word is that she never actually got sent overseas but remained in the United States in the Air Force inventory. There she remained until she was sold out of the military inventory in Arizona; exactly when is obscure. She went to a private owner in Colorado, and then somehow the airplane ended up in Florida owned by a chiropractor.

The next time 5412V turned up in public as far as I know was in 1962 when a man named Ken Van Buren bought her and brought the airplane up to Millville, New Jersey where she would live for a long long time. It was here I first saw 5412V sitting all alone in a hangar at Millville. Little did I know then how I would eventually end the saga of 5412Victor?

Anyway, back to our story. The word we heard around the war bird community was that Van Buren wanted to fly the 51 and actually tried to do it. We heard that he somehow managed to crack the block on the Merlin in the process. This cracking of the block on the Merlin V1650-7 engine that powered N5412V was the event that would ground the airplane for a very long time. There 5412V sat down there at Millville all alone and basically unattended. The engine parts somehow were not coming in to fix the airplane and get it flying again.

Now started a strange odyssey. Van Buren apparently sold the Mustang to an outfit called Tri-State Aviation in Huntsville West Virginia but it still remained at Millville with the cracked block as far as I know. Now enters another buyer from Lancaster, Pennsylvania named Tom Luck. I believe Luck was a Jaguar dealer in Lancaster. 5412V STILL remained at Millville! As far as I can determine, Tom Luck owned 5412V from 1963 to 1967.

In 1967, Bill Gibson came along out of Asbury Park New Jersey. Bill ran a flight school there called Garden State Aviation and had always wanted a P51. He wrangled a deal with Tom Luck and bought 5412Victor for the sum of $4,000.00. Bill Gibson now owned his Mustang!

Where do I fit into all of this you're asking yourselves? Well hang in there with me. I'm getting warmer!!!

Keep in mind that while all this was going on, I personally had no idea of what was taking place as I knew none of the principals personally and had long since lost track of 5412V.

Now we have to leave 5412V for a moment and move on a bit to an air show I was performing in with a P51 in Southern New Jersey in 1971. It was at this show I first met John Trainor. John owned an AT6 and was deeply interested in air racing. He was absolutely nuts about Mustangs, and of course I was flying a Mustang (another one, not 5412V). I think I spent the entire weekend talking P51s with John. He seemed like a fairly nice guy and extremely keen on getting information on the 51. As far as I knew at the time, John hadn't yet flown a Mustang but wanted to get one desperately. Ours wasn't for sale but I didn't mind talking Mustangs with him. We left that weekend trading phone numbers.

I lost track of John Trainor but from time to time he would phone me and we would discuss his questions about Mustangs.

Then one day in 1973 I arrived at the field in Maryland where I was teaching aerobatics to find our mechanic Gale Walker doing an annual on this beautiful orange P51. It was 5412V. Gibson had stripped it clean and repainted it orange with black trim. It was gorgeous! In talking to Gayle I discovered he had worked for Gibson up at Asbury Park before coming to our field to open a shop and Gibson had flown 5412V in early that day and left it there for the annual to be done on it.

Now here begins the strange part of this saga.

I arrived on the field later that week at just the moment Gayle finished doing the annual on 5412V. He needed the 51 moved out to the line and the engine tested! Since I was the only pilot on the field with P51 time, I was asked to do this.

I started the airplane and took it out and ran it up, then parked it on the line. No big deal really, and I did resist the urge to "take it around the patch" and do the roll everybody was clambering for me to do. Somehow I didn't think Bill Gibson would have appreciated that. But something DID happen involving 5412V that afternoon that would forever link me with the airplane. Someone took a photograph of me while I was running up the engine that would later literally become a key player in the story of my life.

Bill Gibson arrived later that day and flew 5412V back to Asbury Park. For all intent and purpose, the airplane was out of my life forever. This was 1973. I talked to John Trainor twice that year. He made no mention of 5412V. I never heard from John again.

Now we have to take this story all the way to 1985. Reader's Digest is doing a feature article on my early life as a boy and how I entered into aviation. ("A Little help From A Friend" Dudley Henriques Reader's Digest April 1985). The story oddly involves a "buzz job" I performed in a P51 Mustang over the grave of a friend. The Digest needed a title page photo shot of me with a P51. Of all the photos I had, the one they wanted was that shot taken of me with 5412V back in 73. I gave them the photo and it was used. The 31 million subscribers to Reader's Digest who read the article in 17 languages would now forever link me to 5412V.

The saga continues…

It's now 2012. I of course have long since retired from active flying and serve as an advisor and consultant to the aviation community on aerobatic flight safety and flight instruction issues. I am also however, as many of you know, an advisor to the flight simulation community. In this capacity I have served Microsoft and various add on developers doing high performance airplanes for the simulator, and the community in general.

I have long enjoyed a personal friendship and professional relationship with Scott Gentile and the development team at A2A Simulations (formerly Shockwave Productions). Much of their work for Microsoft Flight Simulator focuses directly on the area of my expertise. Naturally, I own and have reviewed and written tutorials for their magnificent add on World War II Fighters P51D Mustang, which I have flown for my own enjoyment in Microsoft Flight Simulator 2004.

I have always loved the paint scheme Bill Gibson used on 5412V, and it occurred to me that I would like to have a livery of the airplane done for the A2A Mustang. This was achieved when an extremely talented repainter named Jan Kees Blom created for me an exact replication of 5412V from photographs I sent him for the purpose. I can't stress enough the beautiful job he did on the airplane. It is exactly as it was back in 73.

You might think this strange story ends here but it doesn't. There is one last part.

After Jan Kees had sent me his work I was so impressed with it I put out word in the war bird community that I was interested in knowing if Bill Gibson was still with us somewhere. I wanted to tell him that 5412V was in Microsoft Flight Simulator 2004. Sure enough he was…and is. Bill is living in New Jersey. He's suffered from prostate cancer and is confined to a wheelchair but when I called him we had a long and friendly talk; just two old pilots talking shop… and about our mutual love for

the Mustang. During our talk Bill brought me up to date on 5412V and informed me of something I didn't know until he told me on the phone. John Trainor had bought 5412V from Bill in 1973 and had been killed while flying it in October of 74.

I had heard John had been killed while flying a 51, but I had never actually learned the details of his crash as I was away at the time and I had never guessed that 5412V was the Mustang John had been flying when he was killed.

Bill brought me up to date on what had happened. John had been at Chester County Airport in Pennsylvania for an air show in October of 1974. The weather was bad with about a thousand foot ceiling after the show as airplanes were leaving! John tried to file but couldn't so he decided to take off and file IFR in the air. Witnesses said he took off, called Philadelphia ATC and got a clearance to climb through to VFR on top at six thousand. He never got there. He came off Modena VOR and started the climb. Somewhere in the soup something went wrong.

5412V apparently had a new ADI in it that John hadn't used all that much. I'm told he had about 35 hours in the airplane. He was however a highly experienced ATR rated pilot flying with TWA at the time if I remember right. There is also a theory that there was a coolant leak that sent steam up into the cockpit. This had happened once before. Anyway, a witness saw the 51 diving out of the bottom of the clouds at very high speed. The engine was throttled. The Mustang impacted the ground near Kennett Square (Chatham), Pennsylvania.

My phone conversation with Bill bothered me all week. I got to thinking about the calls John had made to me about the 51 and how badly he wanted to fly one. I was lying in bed thinking about all this one night when for some reason I just got up, came on down here to the den and fired up Flight Simulator 2004. There in all its original glory was 5412Victor, just as it was back in 1974 the day John left Chester County Airport.

Sitting there at the monitor, I don't know what made me do it, but I set up John's flight the way I thought it might have been that day when things went so bad for him. John lived in Weare, New Hampshire. The nearest airport to his home long enough to handle the 51 I guessed would have been Manchester. I created a flight from Chester County to Manchester via the Modena VOR. I set the weather up as close to what it must have been for him the day he filed (1000 overcast with 6000 tops). Then I took off from Chester County into the dark dark sky.

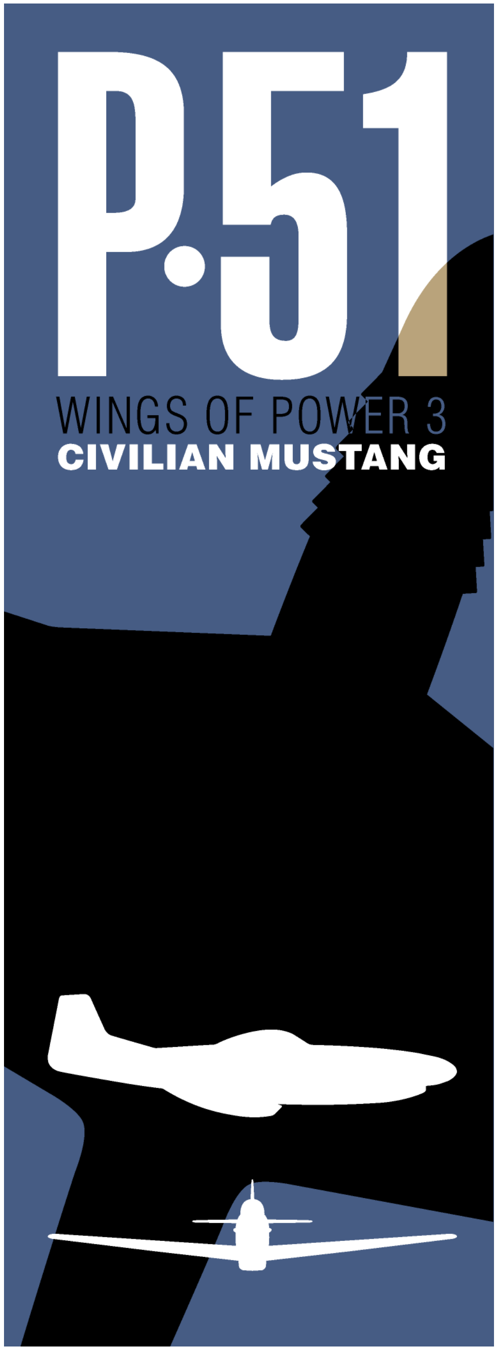
I cleared Modena and began the IFR climb watching the rain hit the windshield. It was eerie! Naturally, as I was in the simulator, all went well and I broke out in a beautiful blue sky at 6000 with puffy Q's all round.

I just sat there thinking about the old days, the old people, and the old airplanes as I flew 5412V the entire flight to Manchester. I landed 5412V and taxied it to the ramp. As I shut it down I thought to myself, "Well John, wherever you are tonight old buddy; it's finished"

God speed.

5412V lives on in FS9 and now FSX. It can be flown in Microsoft Flight Simulator 2004 with Jan Kees textures for the World War II Fighters P51D Mustang which are freeware and can be downloaded at SimOuthouse. In this product the absolutely gorgeous livery we have for the Civilian P51 is an entire new livery done for me by A2A's very own Martin Catney.

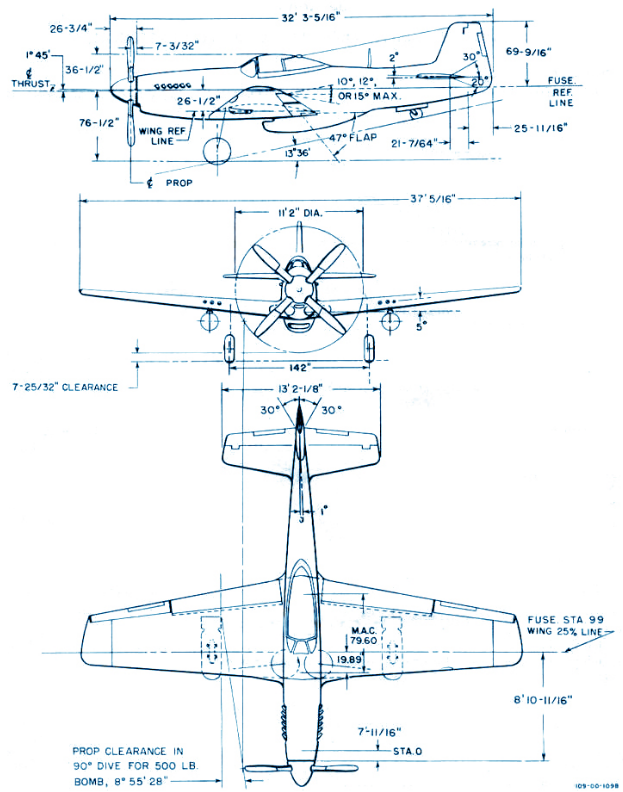
Thanks to Microsoft, A2A Simulations, Jan Kees Blom and Martin Catney, a little piece of my life lives on in Microsoft Flight Simulator.



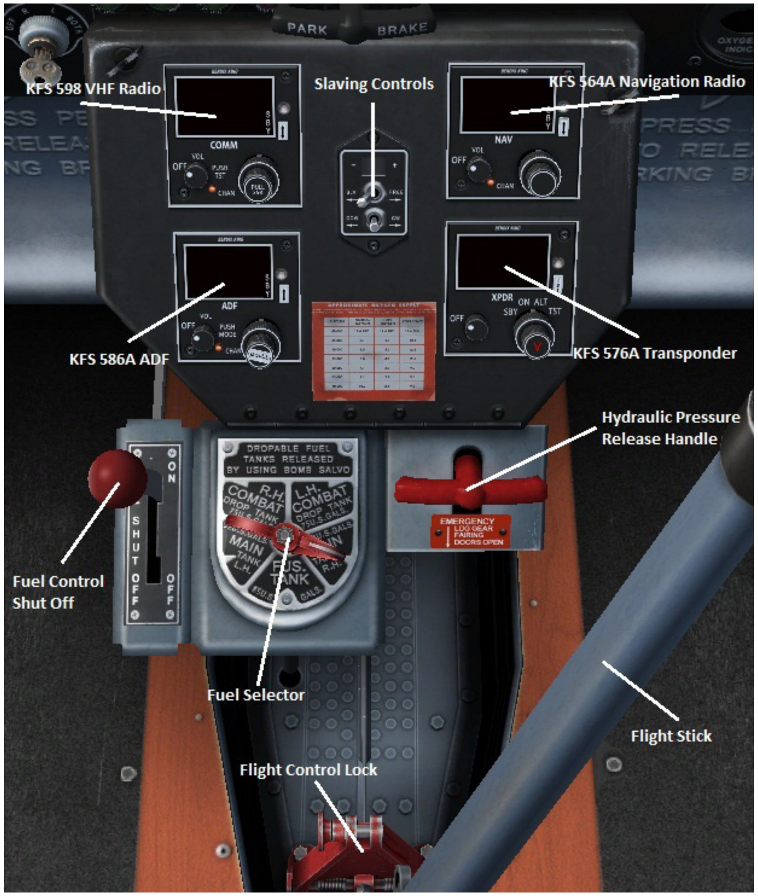
4 Specifications

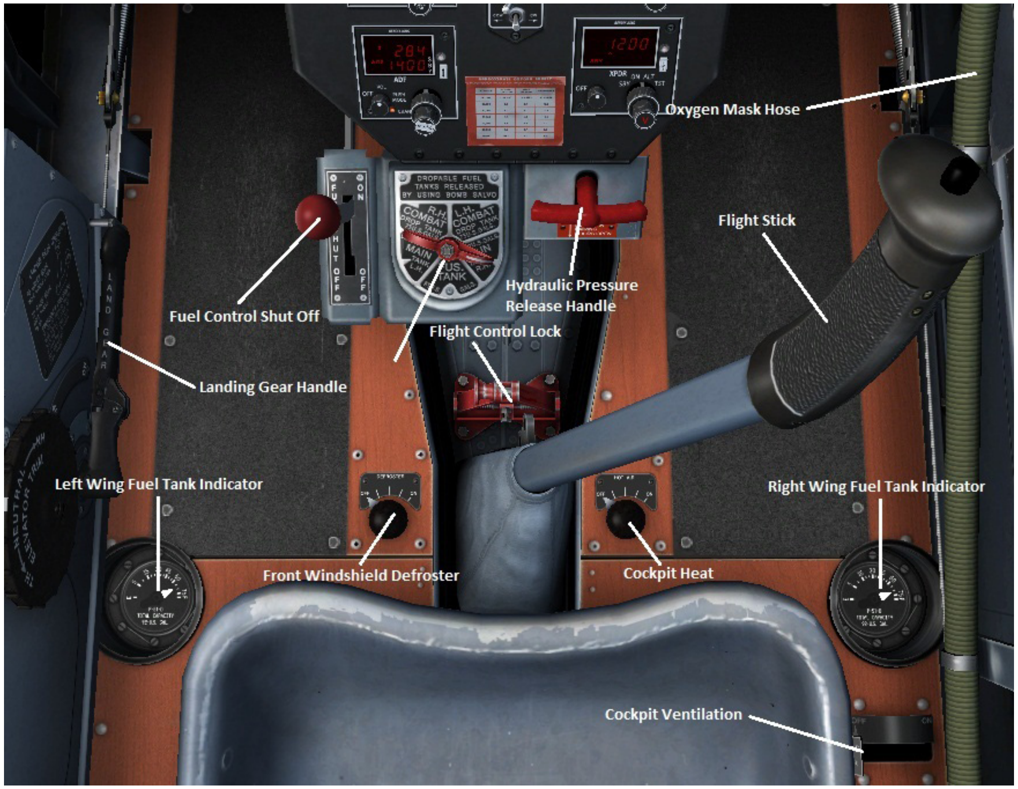
Model P-51D Mustang Specifications

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
Takeoff Run	367 yards
Combat Range	395 miles

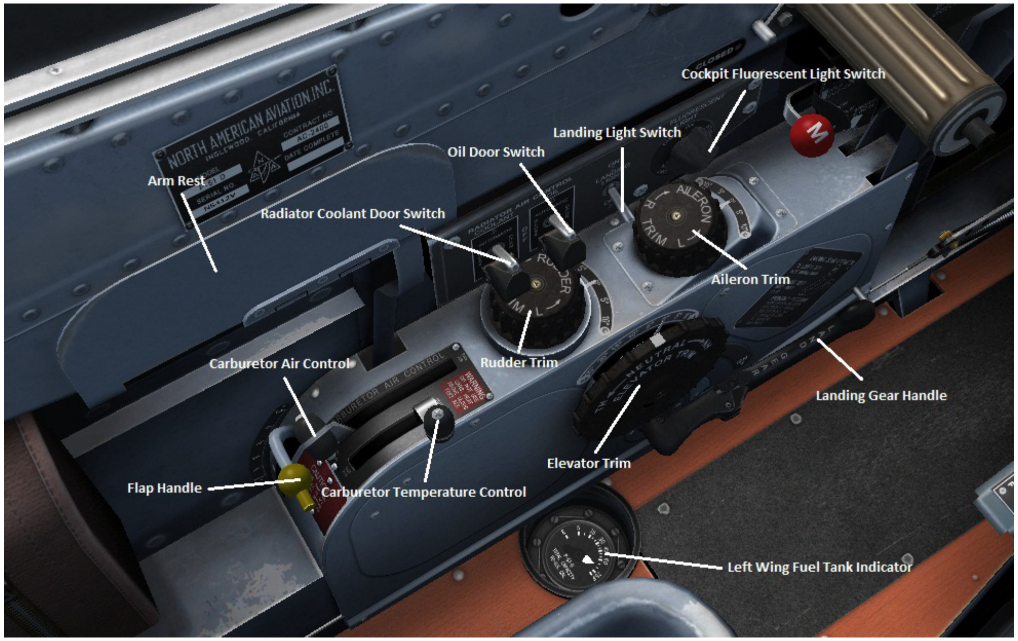


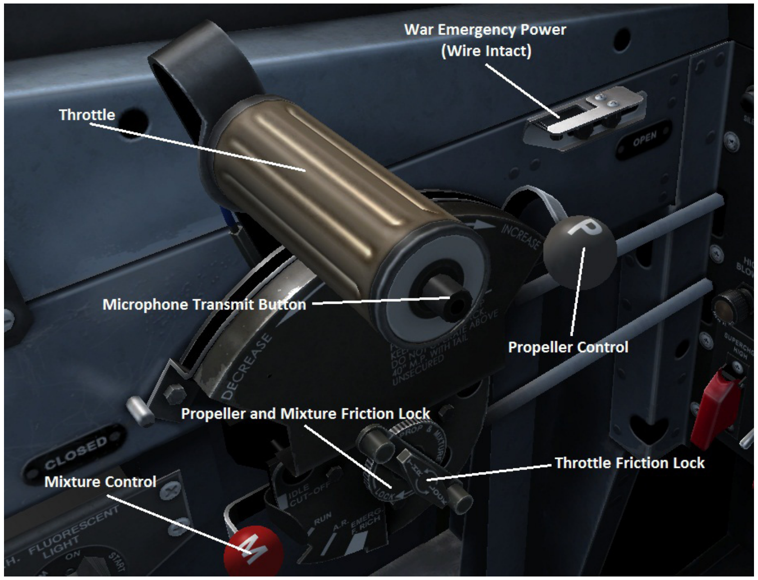
Cockpit Diagrams: Front


KFS 598 VHF Radio
Slaving Controls
KFS 564A Navigation Radio
KFS 586A ADF
KFS 576A Transponder
Hydraulic Pressure Release Handle
Fuel Control Shut Off
Fuel Selector
Flight Stick
Flight Control Lock

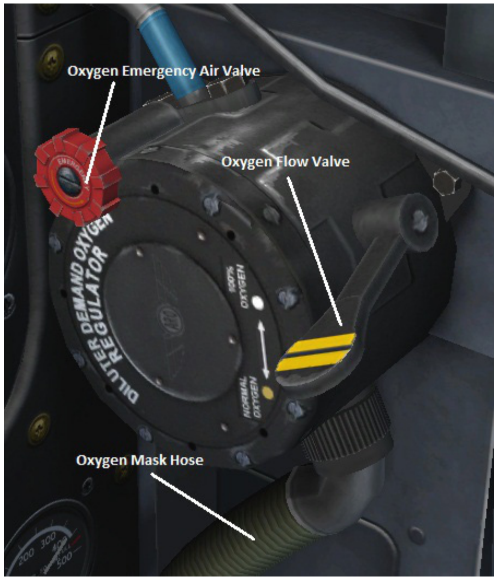

Oxygen Mask Hose
Flight Stick
Hydraulic Pressure Release Handle
Fuel Control Shut Off
Flight Control Lock
Landing Gear Handle
Left Wing Fuel Tank Indicator
Right Wing Fuel Tank Indicator
Front Windshield Defroster
Cockpit Heat
Cockpit Ventilation

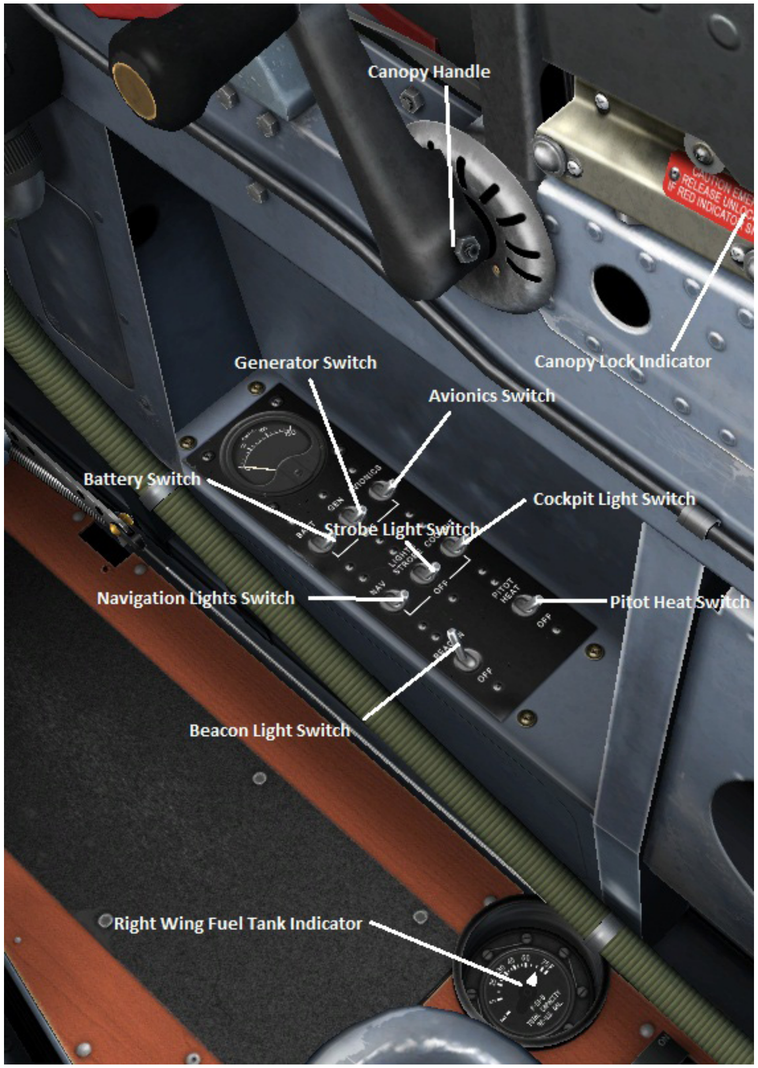
Cockpit Diagrams: Right Side

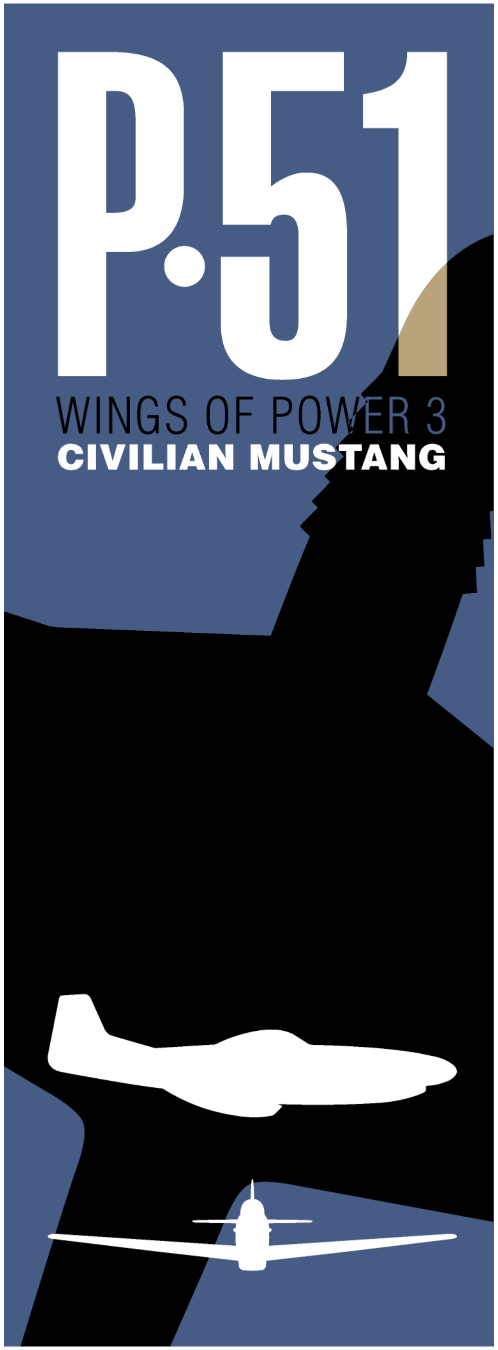




Cockpit Diagrams: Left



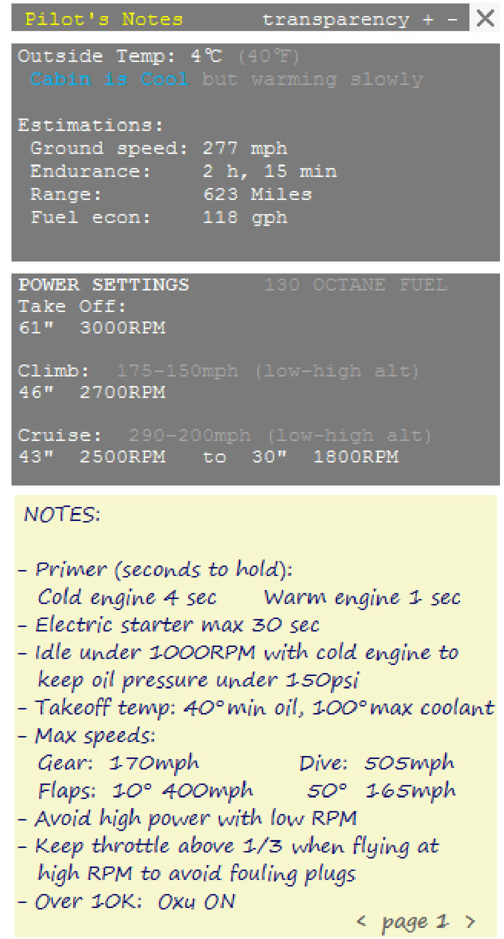




Pilot's Notes (SHIFT-2)

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)

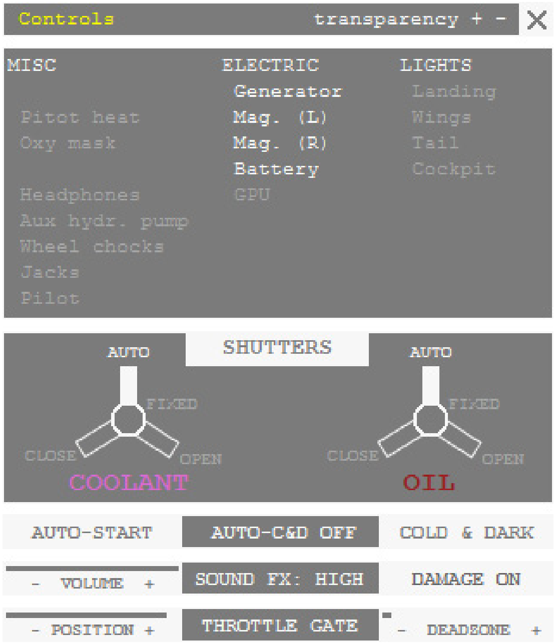
This control panel was initially created to allow you to operate and watch systems like lights and engine flaps while in the external view. It soon became a nice little place where we could put anything we wanted to have quick access to.

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:

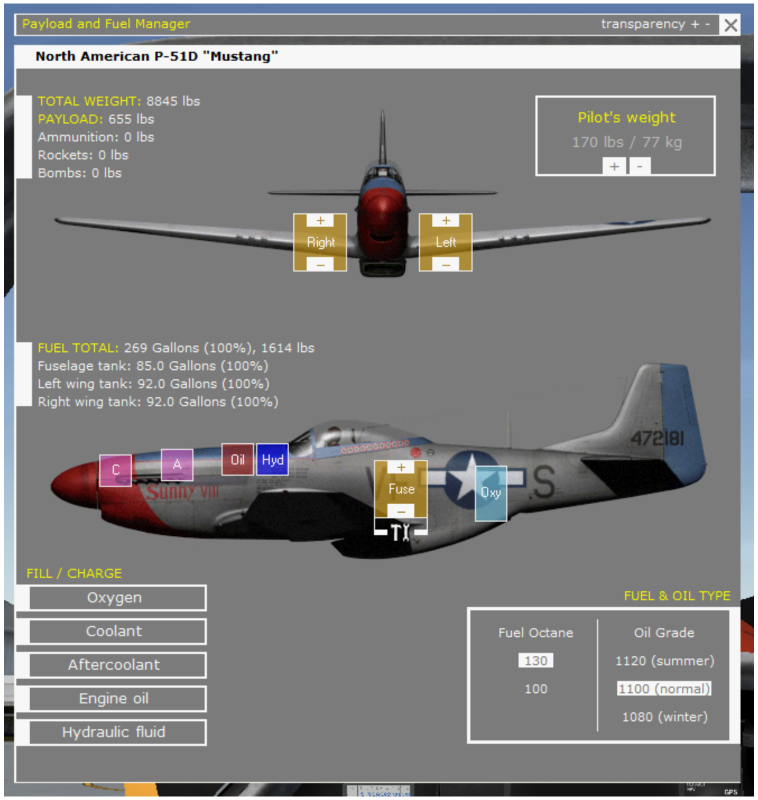
- Enable or disable damage modeling
- Adjust the volume of the Accu-Sim sound system
- Use headphones



Payload & Fuel Manager (SHIFT-4)

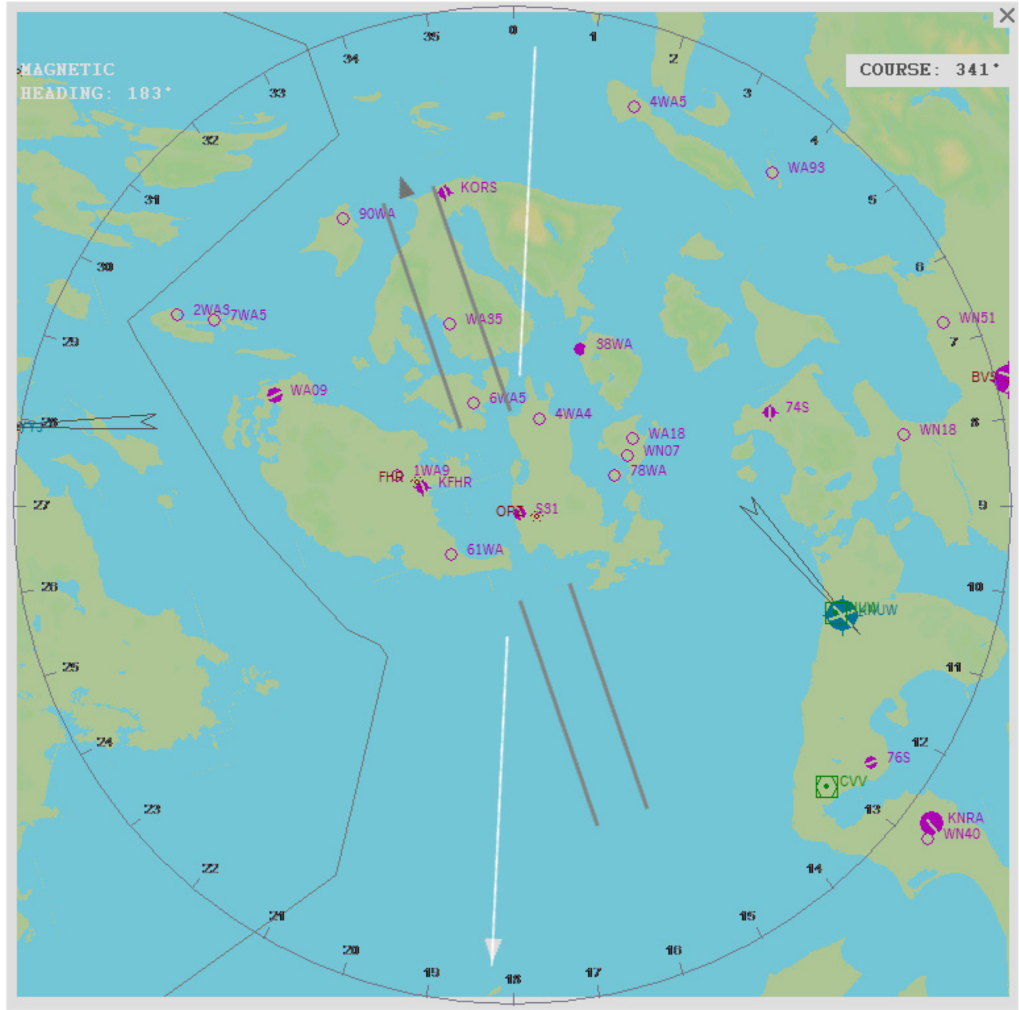
This real-time payload and fuel manager allows you to visually click and load your aircraft. You can service:

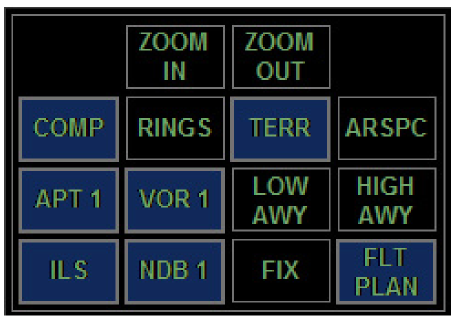
- Fuel
- Oxygen
- Coolant fluid
- Engine oil
- Hydraulic fluid
- Aftercoolant fluid
- Remove fuselage tank
- Change fuel grade
- Change oil grade



Pilot's Map (SHIFT-5)

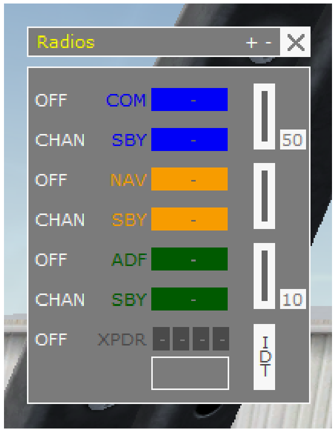
The pilot's map gives full access to similar information that may be found on real maps and allows this information to be easily accessed rather than have to use the default map from the upper menus. This is a period aircraft, so we tried to create this in the true light of a pilot needing to still use 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.





Radios (SHIFT-6)

This small popup panel provides input for your virtual cockpit radios but in a simplified and easy to use manner. This popup features all the amenities of the actual radios but in a singular unit which allows you to control your communication, navigation, ADF and transponder radios from a single source. A few things to note:



- You can switch the active frequency to the standby one by pressing the small white rectangular box at the right.

- You can change the frequency adjustment range by clicking on the small numbered box to the right of the transfer box.

- You can adjust the channels of the particular device by selecting the CHAN button on the right of the window located underneath the ON/OFF toggle.

- Clicking on the IDT button has the same effect as clicking on the physical IDT button of the transponder.

- You can right/left click multiple items on the window to change function and/or frequencies. For example, below the transponder code you can change the function from “standby” to “on” by right clicking on the box.

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:

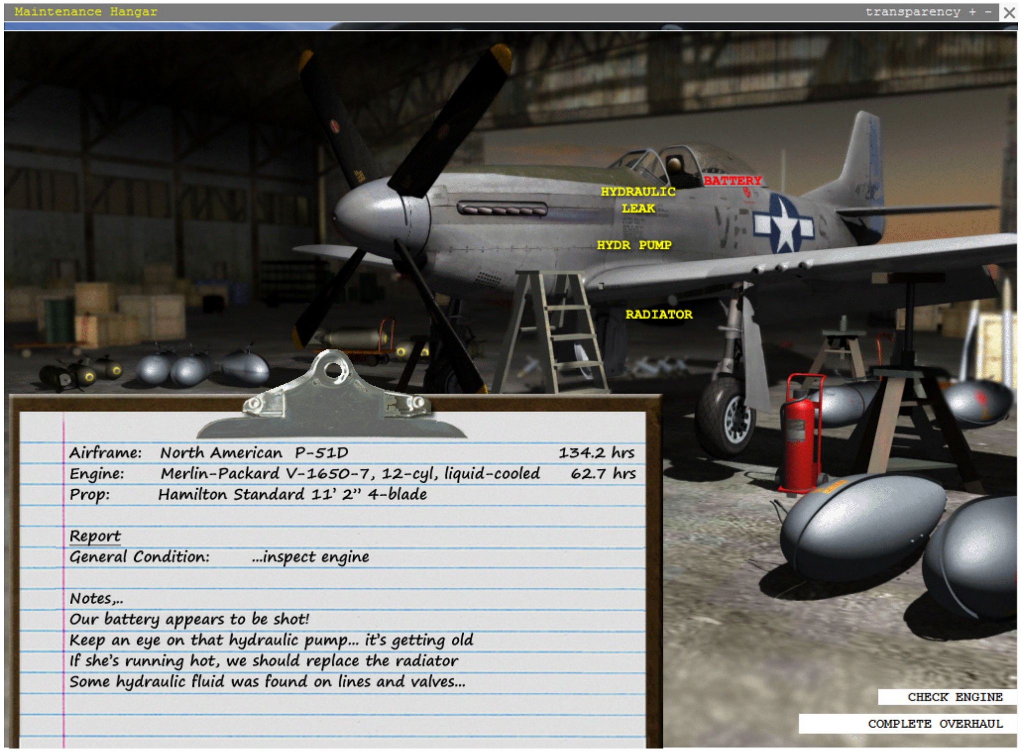
- A summary of your airframe, engine, and propeller installed
- Hours on airframe and engine since last major overhaul
- General condition of the engine
- Notes

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.

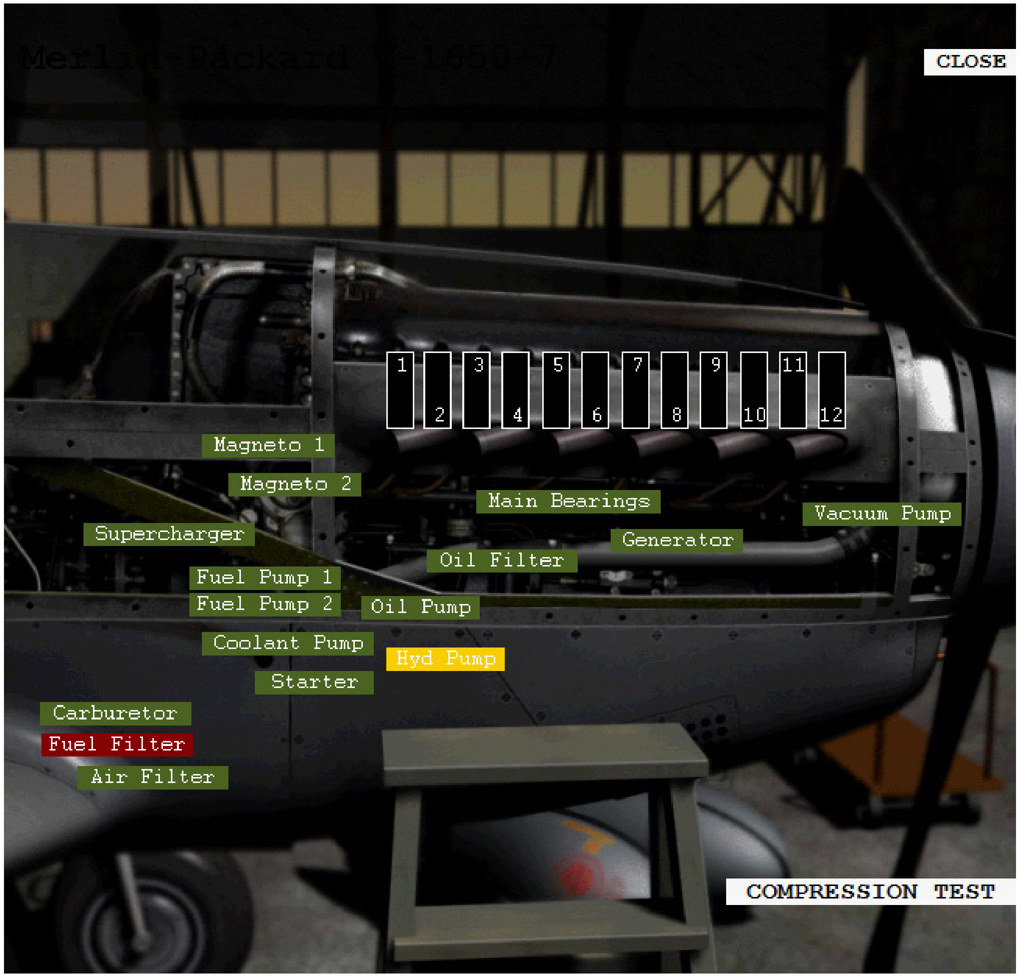


Color Codes

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.



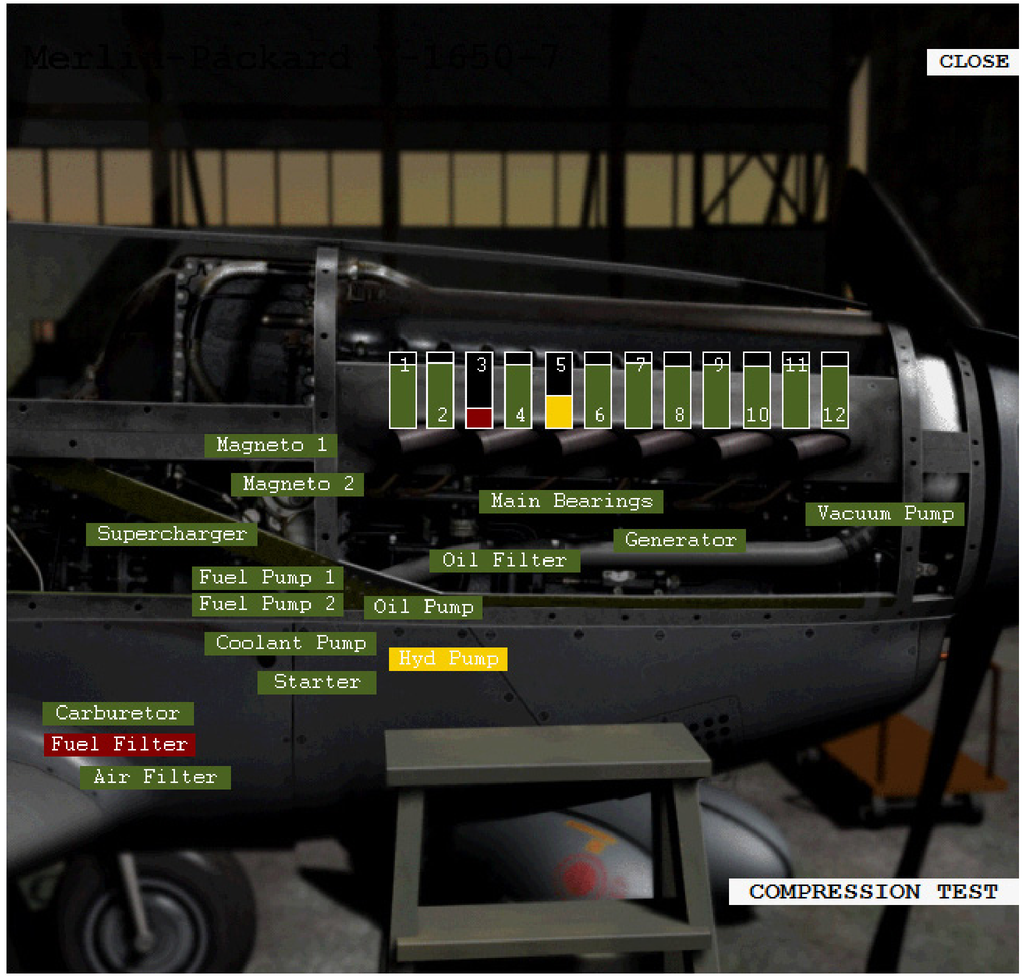
At the lower right is a “Compression Test” button, which tells your mechanic to run a high-pressure air test on the engine cylinders, checking for leaks past the cylinder rings. A civilian may choose to replace a cylinder that is only showing modest wear, perhaps in the 50-60psi range, whereas the military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

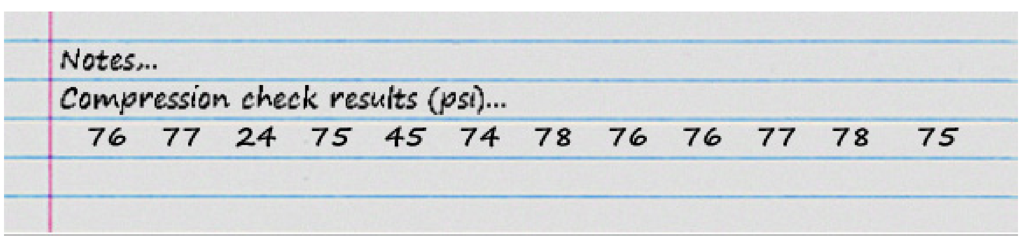
Low compression on a cylinder isn’t necessarily a terrible thing, because as the engine picks up in speed, the worn cylinder becomes productive. It is mostly noticed at lower R.P.M.’s where the cylinder may have trouble firing, and also a marked increase in oil consumption may also occur (sometimes with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





GPS (SHIFT-8)

This GPS functions the same as the one in the virtual cockpit. For a thorough description of how to utilize the GPS please read the guides provided with Microsoft Flight Simulator X. Please note that the GPS in the virtual cockpit can be easily swapped with a 2D one should one desire to swap the unit with other avionics freely available to consumers. For more information on how to accomplish this please see any manuals/ guides or author's notes for the device you wish to utilize.

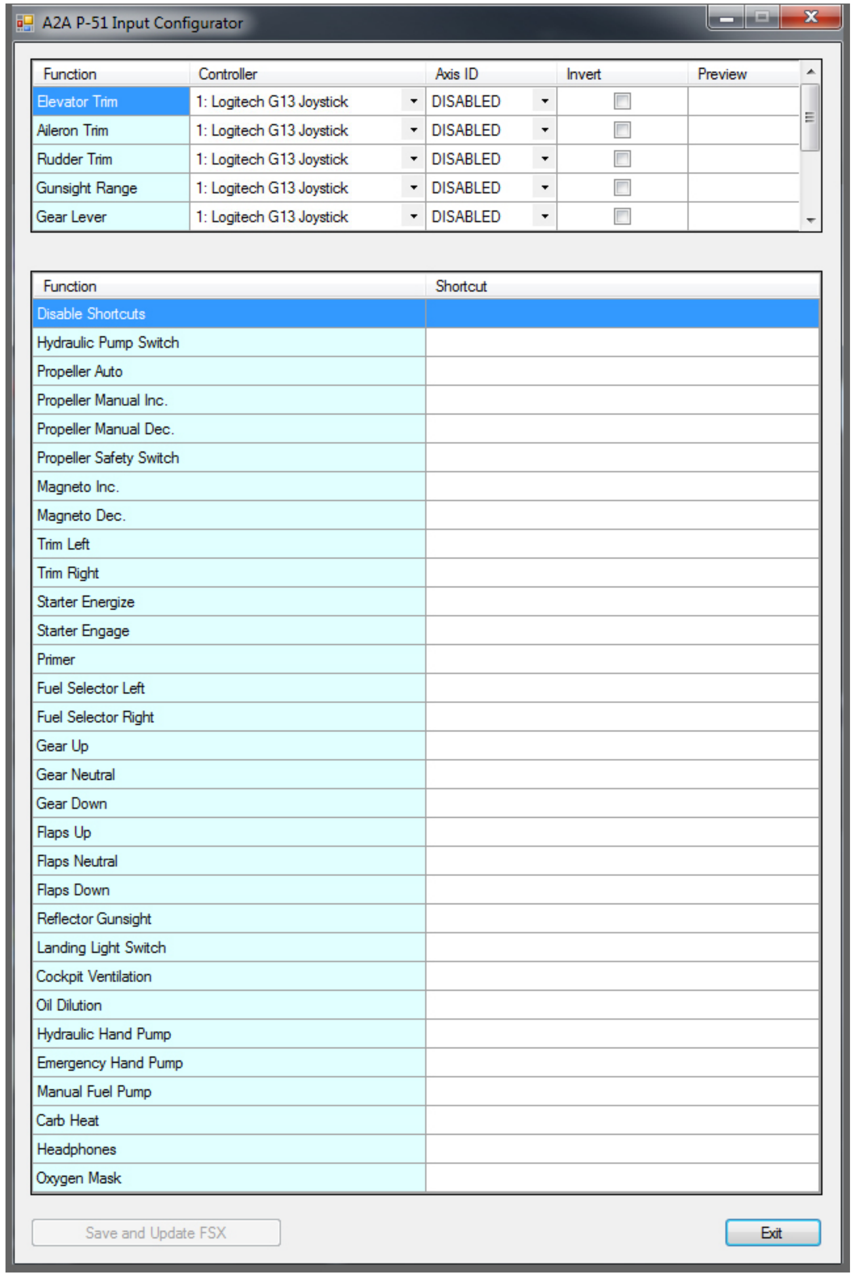
Joystick Mapping Utility

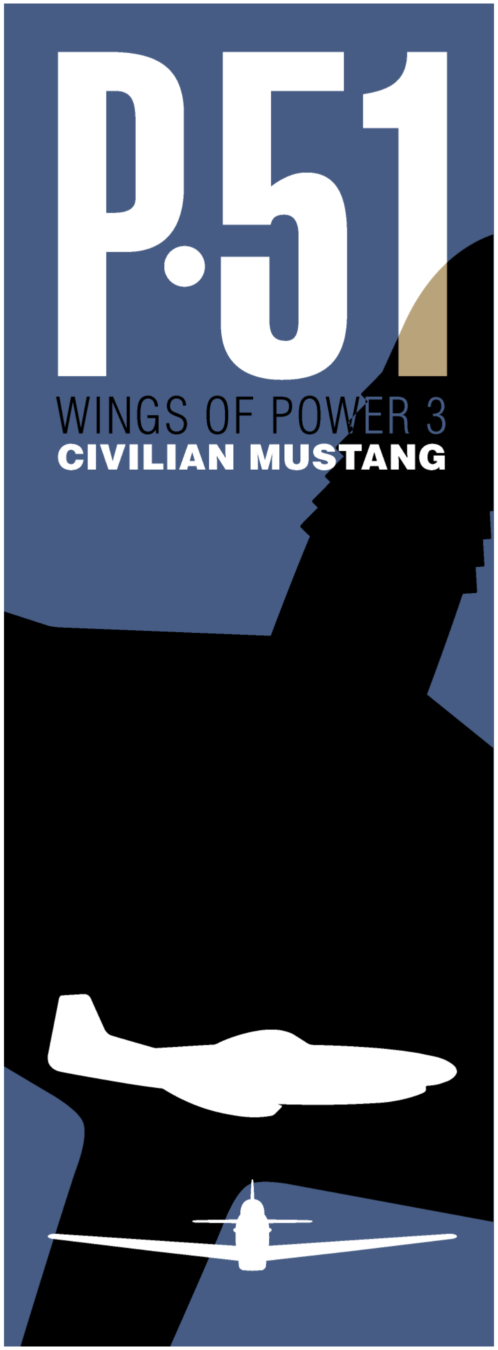
The Input Configurator is a small utility that allows users to assign keyboard or joystick mappings to many custom functions that can't be found in FSX controls assignments menu. It can be found in the A2A/P-51/Tools folder inside your FSX installation directory.

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.

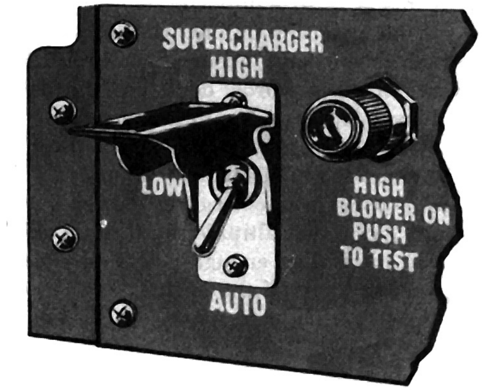
The lower table is the shortcuts menu. Hover over function name to bring up a tooltip with additional information. To make a new shortcut, double click on a selected row to bring up the assignment window. Then press keyboard key or joystick button you want to assign to this function. For keyboard it's also possible to use modifier keys (Ctrl, Shift, Alt).

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





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.

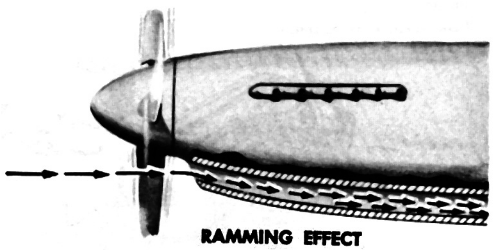
If the aneroid switch fails, the supercharger automatically returns to low blower.

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.

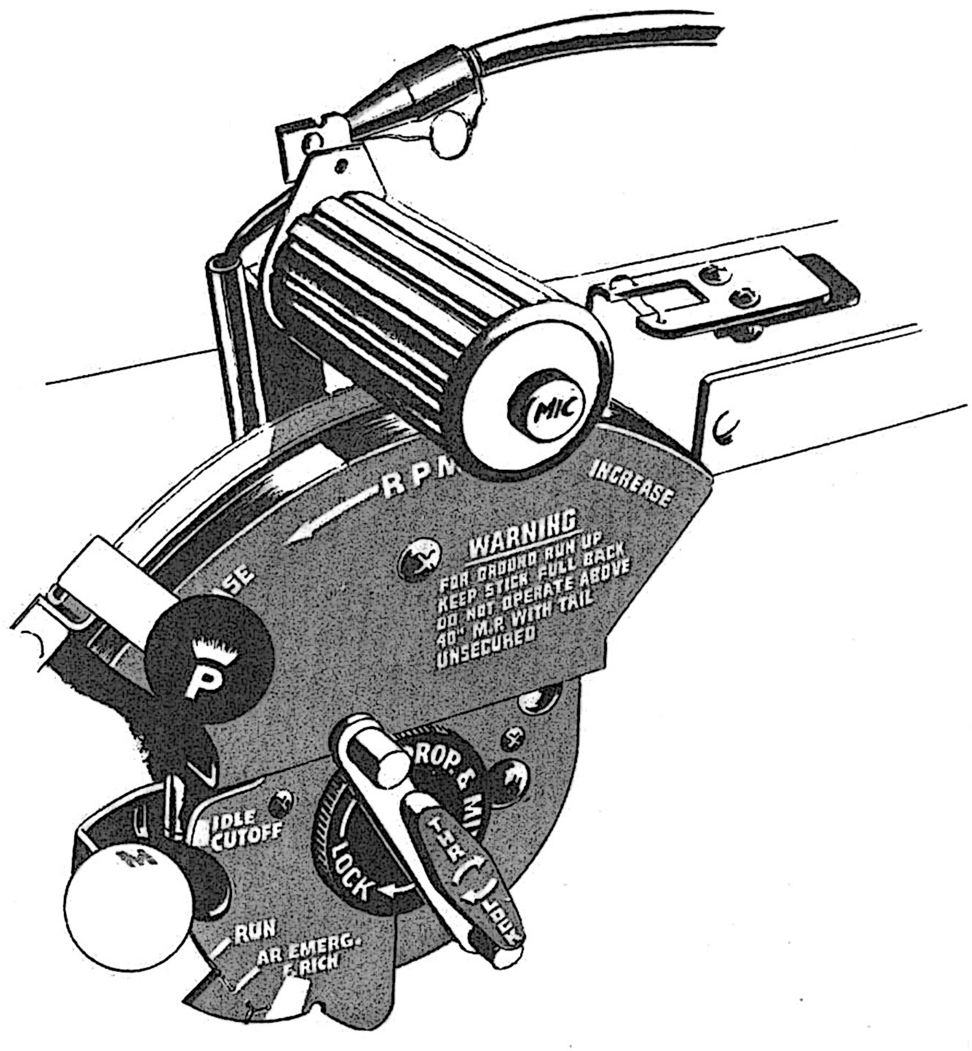
Throttle Quadrant

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.

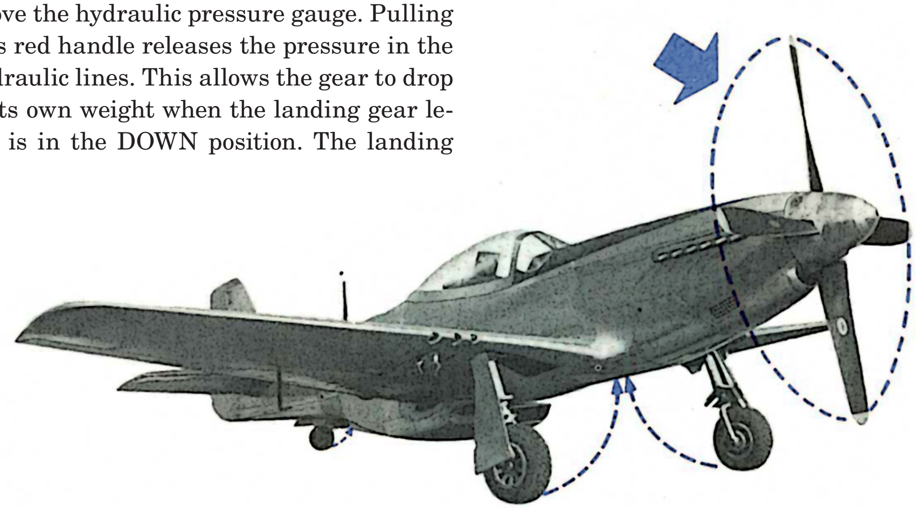
The tailwheel is both steerable and full swiveling. It is steerable 6° right or left with the rudder. The tailwheel lock is different from that of most other planes-it is operated by the control stick. When the stick is in neutral position or pulled back, the tailwheel is locked and steerable. When you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



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.

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.

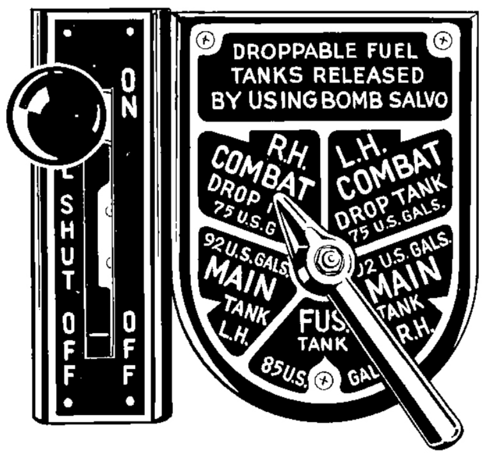
In case of engine driven pump failure, the booster pumps will provide enough fuel to the carburetor for normal engine operation.

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.

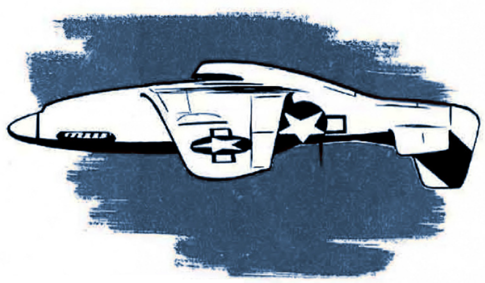
However, when the plane is in inverted flight, the oil pressure falls off because no oil reaches the scavenger pump. For that reason you must limit inverted flying to 10 seconds-which is plenty of time for any normal or combat maneuvers.

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

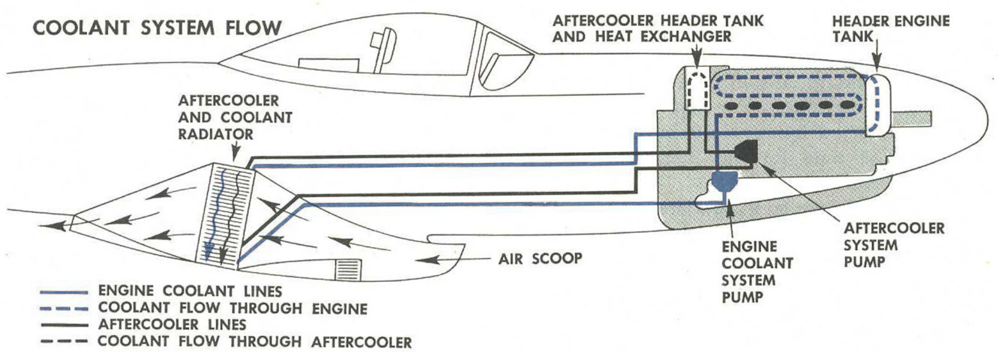
With the radiators located in the big airscoop aft of the cockpit under the fuselage, the cooling cools the engine proper.

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.

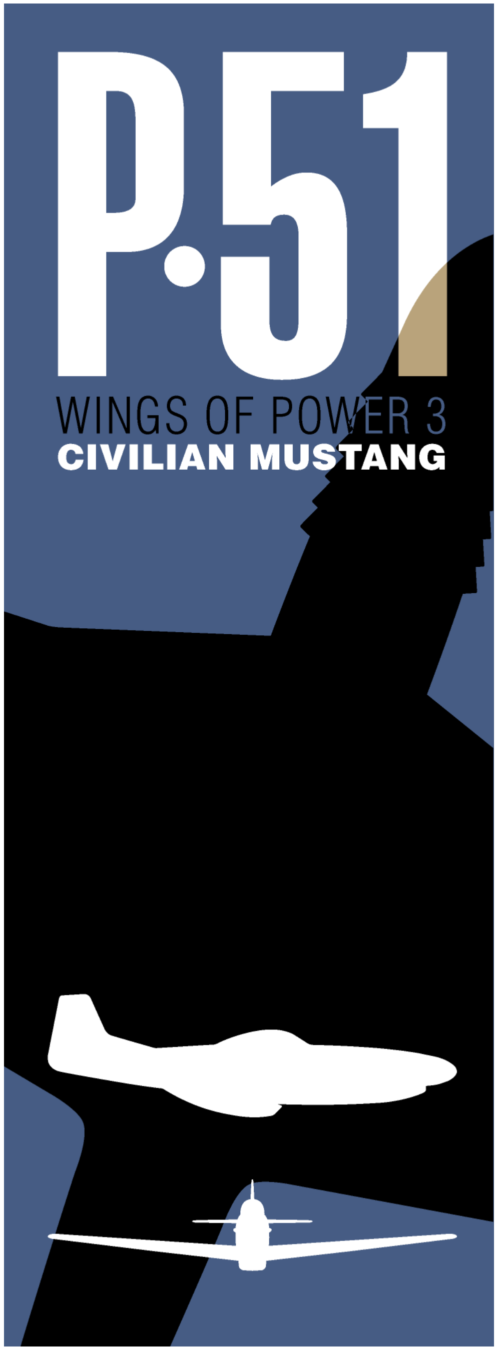
Your oxygen supply is carried in four tanks, which are installed just aft of the fuselage fuel tank. There are two D-2 and two F-2 tanks (which have twice the capacity of the D-2's), for a total volume of 3000 cubic inches. A filler valve, accessible through a small door in the left side of the fuselage,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

Recognition Lights

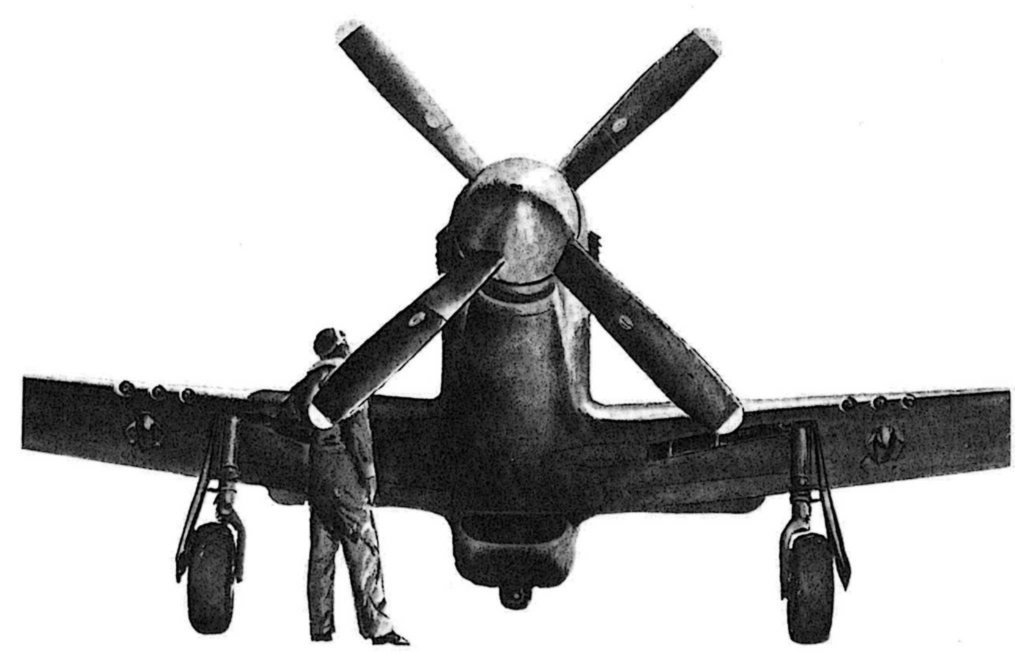
Three colored recognition lights (red, green, and amber) are located on the underside of the right wing, near the tip. By means of three position toggle switches on the electrical switch panel at your right, these lights can be used in any combination. You can burn them steadily, or flash code signals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



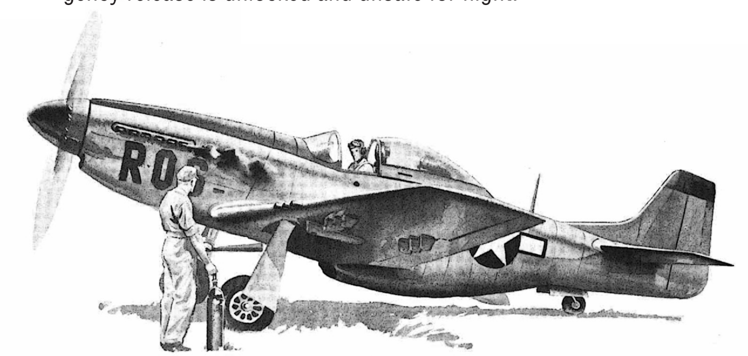
Preliminary Check

- 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

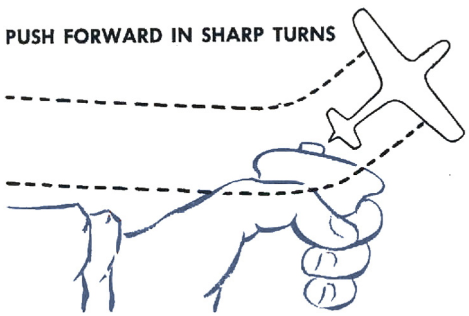
- Ignition switch OFF.
- Have prop pulled through if it has been idle more than 2 hours.
- Generator and battery switch ON, unless battery cart is being used, then battery switch OFF.
- Throttle 1 inch open.
- Mixture control in IDLE CUT-OFF.
- Propeller control in INCREASED RPM.
- Supercharger switch 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 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 ON. 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)

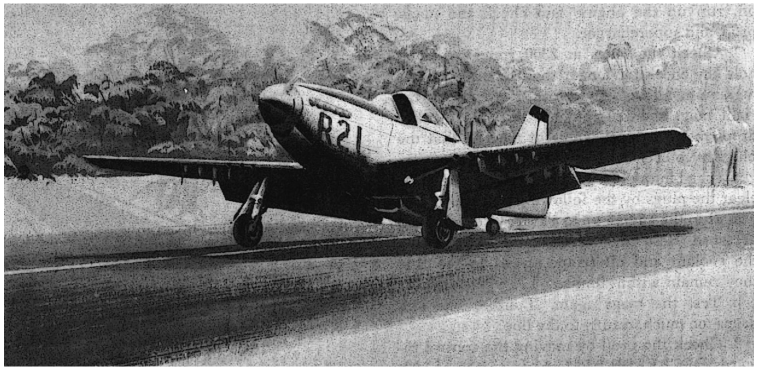
- At 2000 RPM, check the following:

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.

Go Around Procedure

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

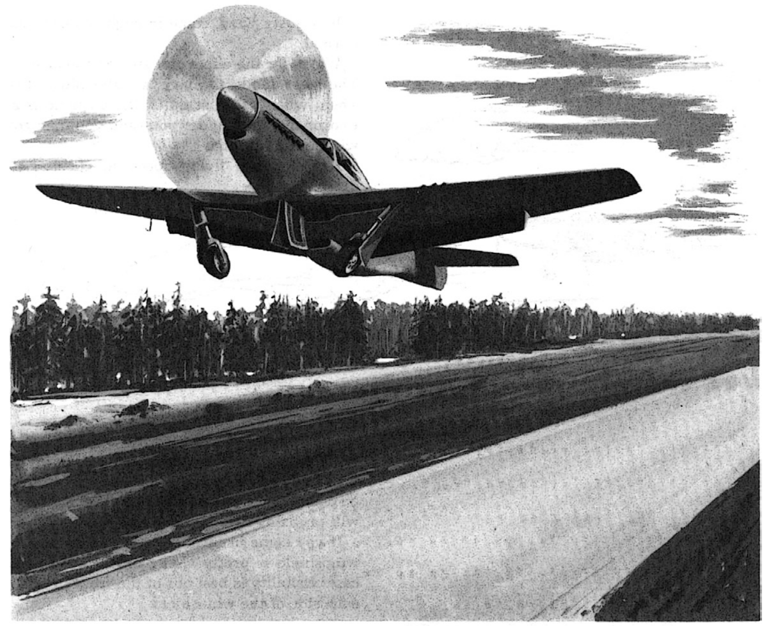
It's done in the best of families. The recommended go-around procedure is:

- 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 sideslipping 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.

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.

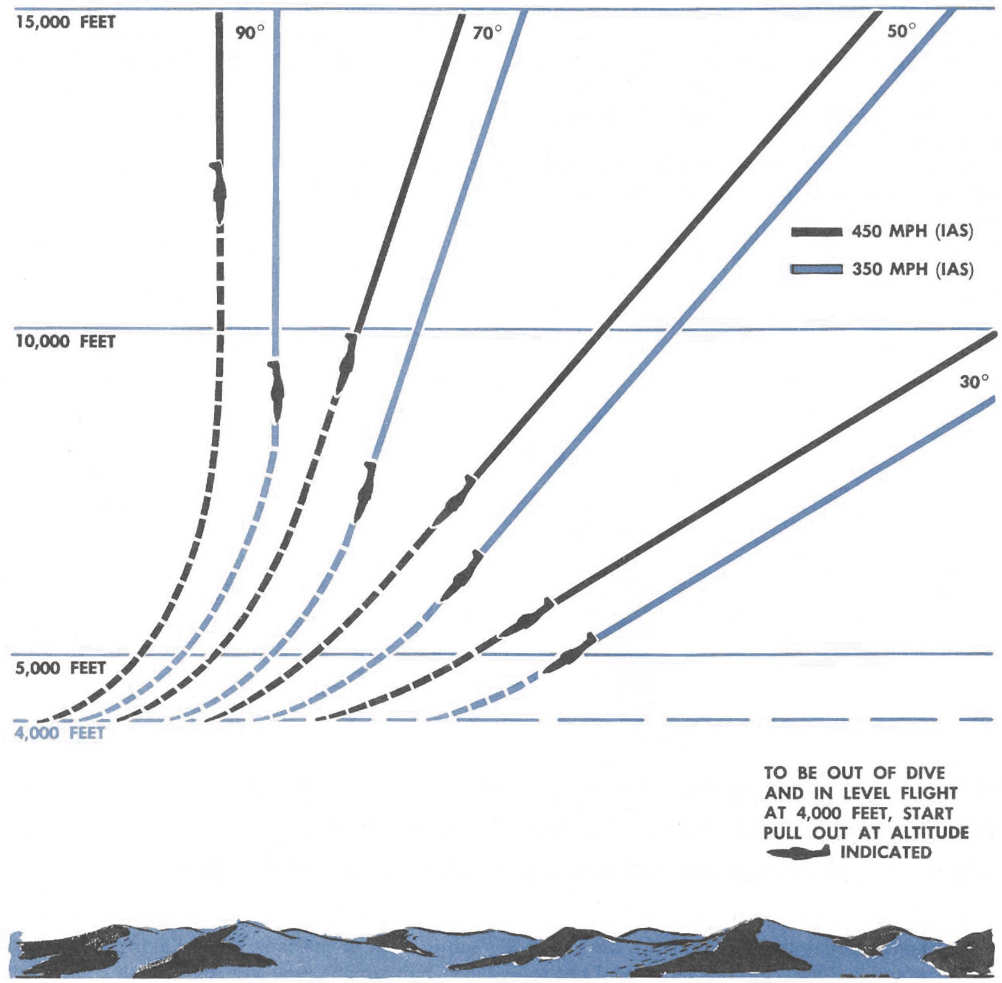
It is capable of developing terrific speeds which makes it no toy to be played with. Yet its handling, even in high-speed dives, is not difficult if you know what you're doing.

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 pullout 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

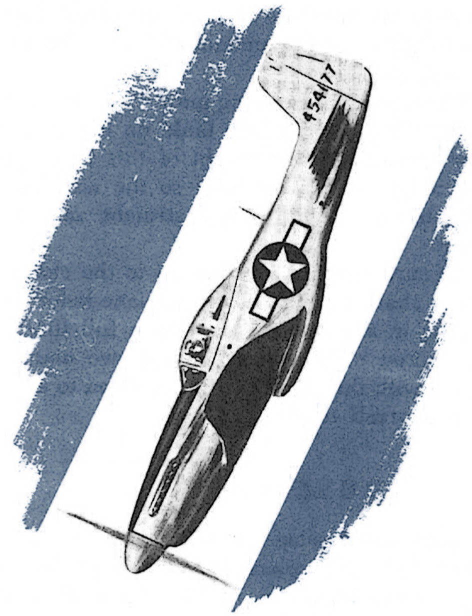
The recommended procedure for recovering from a high-speed dive is:

- 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.

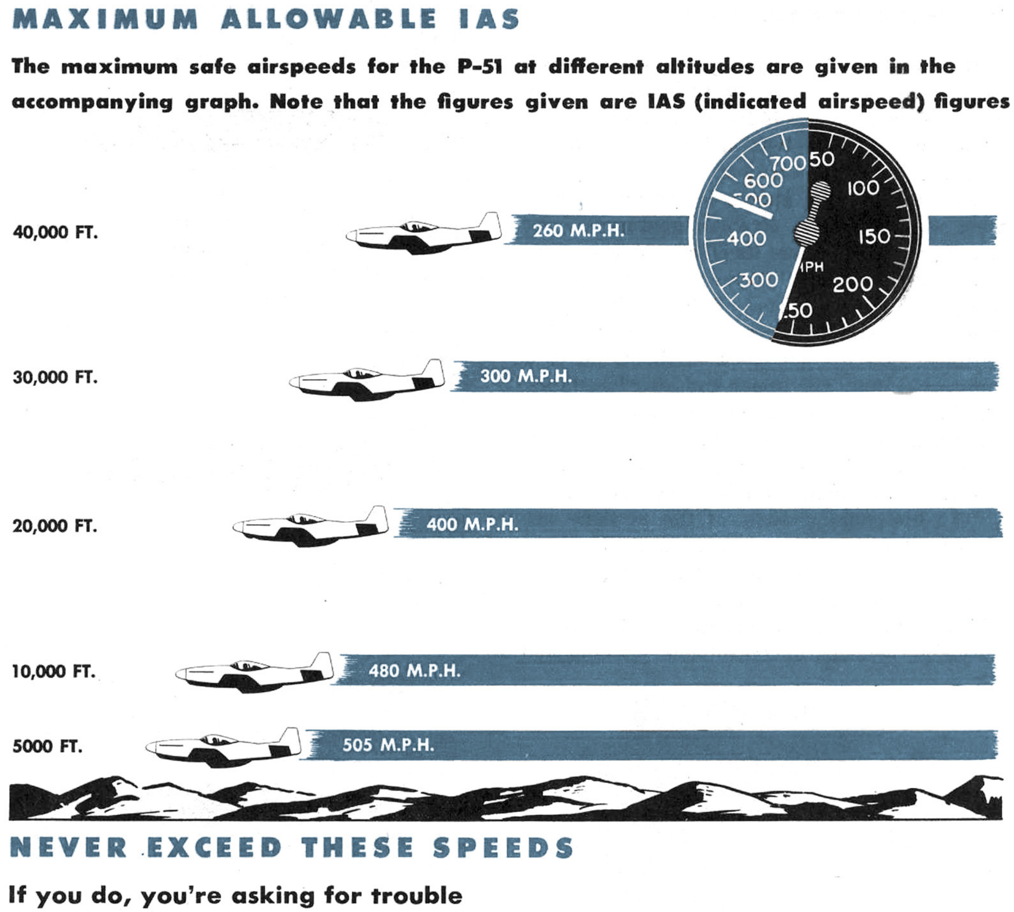
Notice that at altitudes above 5000 feet the figures are less than 505 IAS (the red-line figure on the airspeed indicator of the airplane).

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

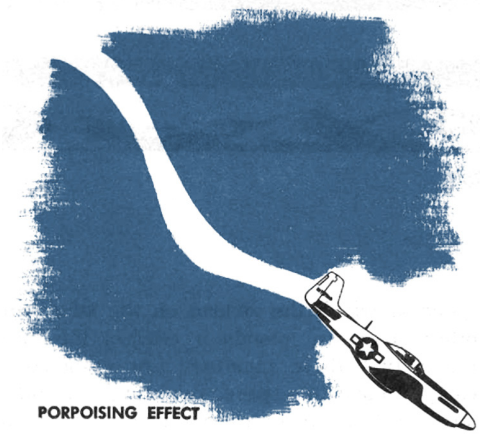
In other words, the red-line figure for the P-51 is not a fixed figure but a variable figure-variable with altitude. The higher you go, the lower the maximum allowable IAS. This is true of all ultra-fast, high-altitude fighter planes used for high-speed diving.

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.



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.

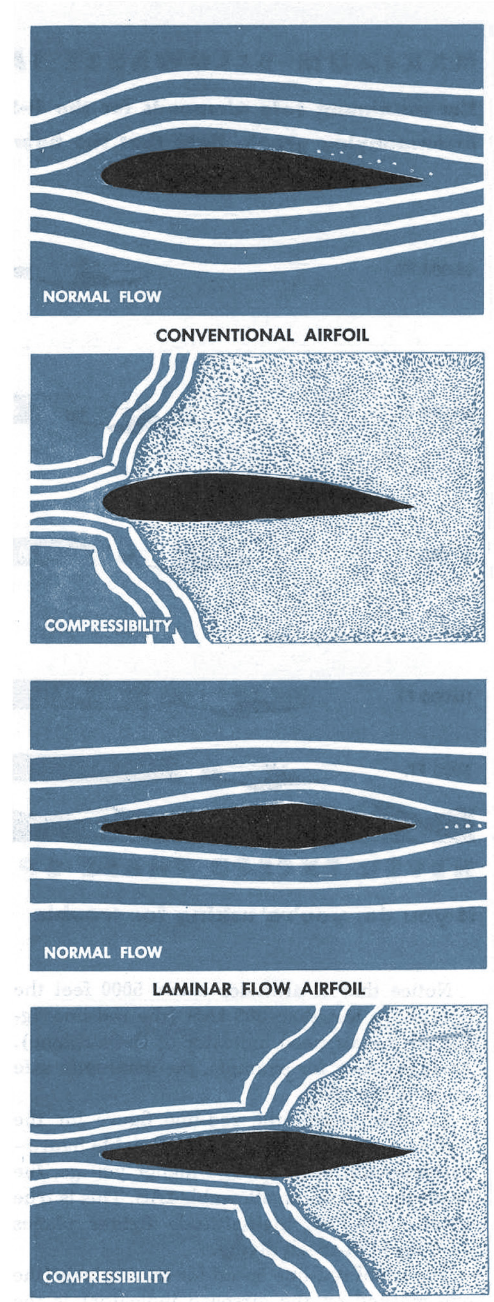
If the speed of the airplane isn't checked and the pilot doesn't regain control of it, either the terrific vibrations of the shock waves cause structural failure or the airplane crashes while still in the compressibility dive.

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.

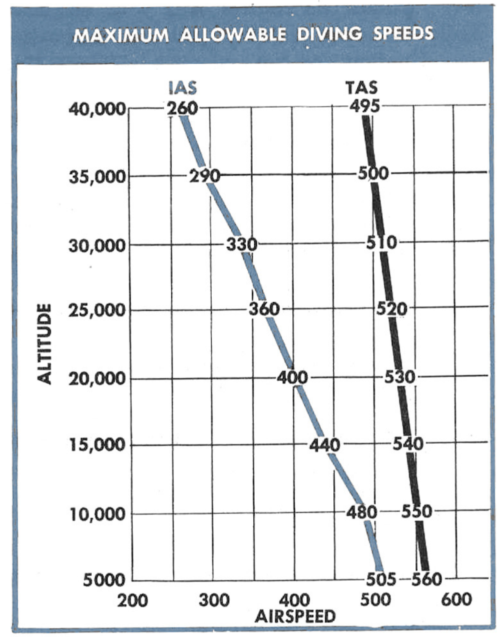
The higher you are, therefore, the sooner you approach the speed of sound. And, the higher you are, the lower your safe IAS

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

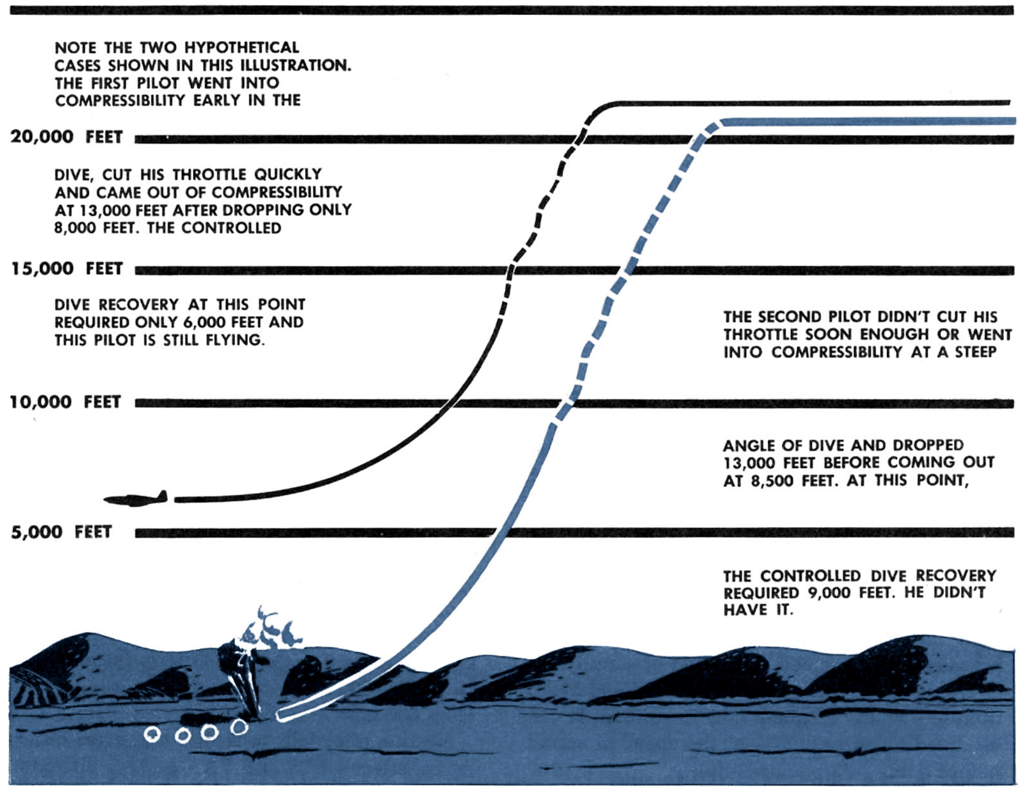
As noted earlier, it is possible to come out of compressibility safely if you don't go into it too far. The most important thing to remember about this is that while in compressibility you have virtually no control over your airplane.

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.

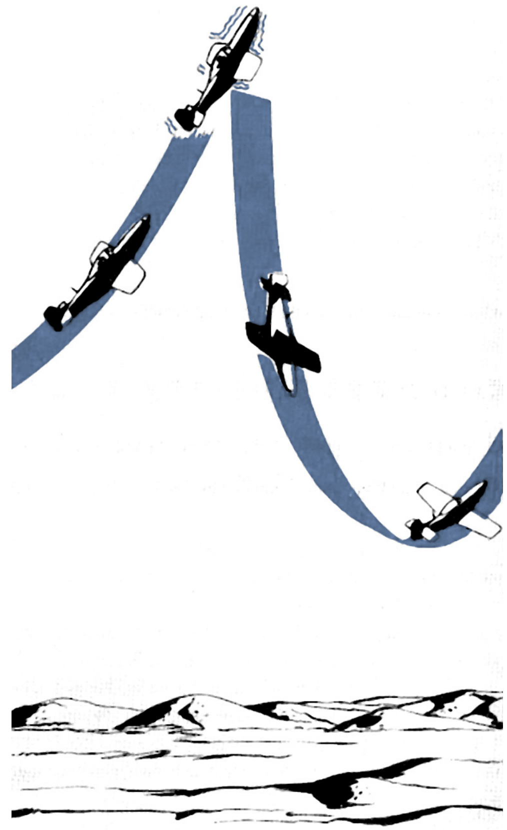
Violence of the elevator buffet increases with the speed of the stall.

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.

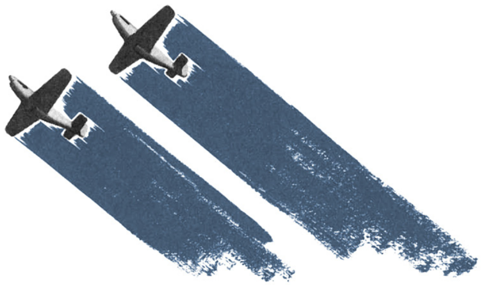
If you should ever get into a power spin, cut the throttle immediately and follow the normal recovery procedure. Be sure to hold the controls in the recovery position until you have recovered completely. It may take up to six turns to recover from a two to five turn power spin. In this situation you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

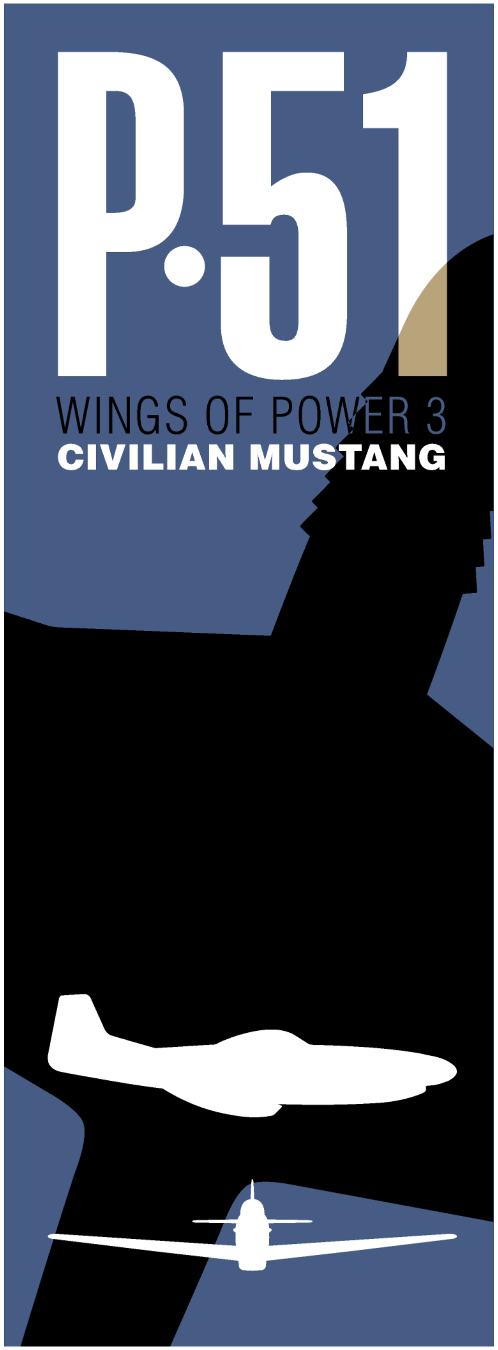
- Put the landing gear control handle in the DOWN position. This releases the mechanical locks which hold the gear in place.
- Pull the red emergency knob. This releases the hydraulic pressure in the lines and allows the gear to drop of its own weight.

Rock It to Lock It

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.



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