T-6

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ACCU-SIM T-6 TEXAN

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T-6 TEXAN

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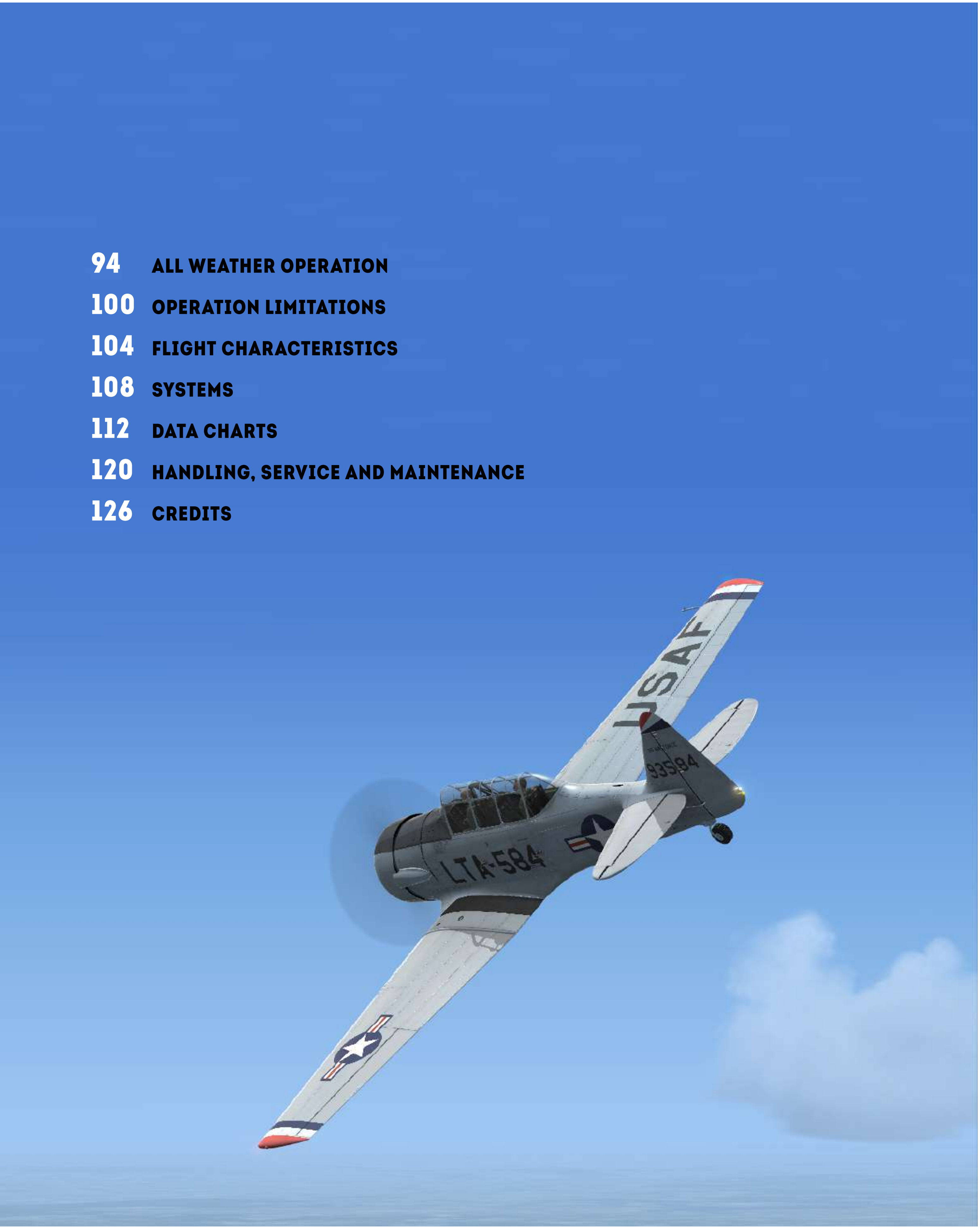
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THE NORTH AMERICAN T-6

BY MITCHELL GLICKSMAN © 2016

Mustang! Thunderbolt! Hellcat! Corsair! Spitfire! Hurricane! These and many of the other great Allied fighter aircraft of World War Two are highly familiar to a great many people and to everyone interested in aviation history. All of these aeroplanes and the valiant pilots who flew them did their very crucial part to ensure the Allied victory over Nazi Germany and the Empire of Japan.

However, what all of these pilots who flew these aeroplanes, all of the celebrated aces and all of those who flew with them have in common is one aeroplane, one which is not nearly as well-known or popularly celebrated — the North American (NAA) T-6, or AT-6 as it was called in the U.S. Army Air Force (USAAF), SNJ in the U.S. Navy (USN) and U.S. Marine Corps (USMC), and "Harvard" in the Royal Air Force (RAF) and Royal Canadian Air Force (RCAF). Virtually every one of the pilots who flew against the Nazi and Imperial Japanese air forces, learned the art and craft of combat flying and honed their aeronautic skills to a diamond- sharp tip in the AT-6 before they were given leave to go into harm's way in Mustangs, Hellcats and Spitfires.

Compared to those mighty and oft-heralded fighter aircraft, the relatively obscure AT-6/SNJ is the common bond that ties all of these pilots together and which enabled them to "go forth and vanquish the foe" so successfully. Many thousands of young, eager pilots owe their very survival in the mad swirl of aerial combat and the rest of their lives thereafter to the lessons they learned whilst in the cockpit of an AT-6, so successfully and profoundly did this humble aeroplane perform its role and do its duty.

MILITARY FLIGHT TRAINING IN THE MIDDLE 1930s

As it is the North American T-6 G that we are mostly concerned with herein, the following will primarily discuss U.S. and British flight training in the late '30s and during World War II. To state the obvious, military flight training was then and still is intended to gradually bring the completely uninitiated new cadet to the point where he is competent to fly first- line combat aircraft (in the times discussed herein, except in the Soviet Union, women were excluded from military flight training). A similar flight training curriculum was followed in virtually all of the major air forces at that time which was accomplished in three distinct steps, Primary, then Basic training, followed by a short period of Transitional or Operational training in aircraft in service.

PRIMARY FLIGHT TRAINING

Since the beginning of military aviation, of necessity, all major air forces have had a Primary flight school. Between 1926 and 1938 all United States Army Air Corps (USAAC)[1] Primary Flight Training was given at the Air Corps Training Center, first at Duncan Field, an annex of Kelley Field near San Antonio, Texas and later at Randolph Field near Universal City, Texas. In time, other training centres arose in southern Texas, an area chosen for such because the topography is an enormous, flat plain which enjoys year-round excellent flying weather. With virtually all USAAC flight training being held at these locations right through World War Two (WWII) it is no wonder that the coming AT-6 trainer aircraft was dubbed "Texan"[2]. The USN/USMC Flight Training Centre was at Pensacola, Florida.

As the number of flight cadets grew exponentially from the middle 1930s to 1940, the Civil Aeronautics Act of 1938 was passed authorizing and funding a trial program for what would become the Civilian Pilot Training Program (CPTP). On 27 December 1938, President Roosevelt announced the program which was to provide pilot training for 20,000 college students a year. All Primary Flight Training in the U.S. was thereby transferred to Army contracted civilian flight schools following a strict Army curriculum and using U.S. Army owned aircraft. It was here that the venerable Piper "Cub" was often the aircraft of choice for Primary Training. Other aircraft used for Primary Training were: Consolidated PT-1 "Trusty", Stearman PT-13D "Kaydet", Ryan YPT-16, Fairchild PT-19/26 "Cornell" and Ryan PT-22 "Recruit".

Using civilian flight schools for Primary Training freed up the USAAC and USN/USMC training centres for Basic flight training. Eventually a Pre-Flight stage was added to weed out those cadets who were deemed unfit to continue to Primary Flight School. During Pre-Flight screening, prospective cadets took rigourous classes in mathematics, the hard sciences (primarily chemistry and physics) as well as aerodynamics, aeronautics and three-dimensional geometry at the San Antonio Aviation Cadet Center, Texas; at Maxwell Field, Alabama, at the Santa Ana Army Air Base, California or at Pensacola for USN/USMC cadets. As may well be imagined, this programme weeded out a great number of would-be cadets.

After the Nazi invasion of Poland on 1 September 1939, the United States began to build up its armed services as most practical-minded officials saw that it was very likely that the U.S. would soon become involved therein. In 1940, to create a greater number of pilots ready to serve, two more Air Corps

North American T-6G/SNJ-7, the last and best of the breed in typical post-war U.S. Air Force/Navy “trainer yellow”, a dark yellow/orange called “ANA Orange Yellow”, “Identification Yellow” or a darker shade, “Yellow # 4” (FS 13538)[3], selected for its high visibility in all weather conditions. “ANA” (also seen as “A-N”) stands for “Army and Navy”, a joint collaboration with regard to establishing and enumerating official aircraft paint colours in 1943. With numerous aircraft concentrated in the traffic patterns around military training fields, the easier their pilots could see each other the better, thus this bright colour. Also, in the event that one of them went down off-field or in the water, this high- vis paint made it more likely that they would quickly be found.

Restored AT-6D with LP-21 rotatable loop ADF antenna in an aerodynamic ‘egg’ housing. This aeroplane is typical of those by the used by the USAAF for Advanced flight training during World War II seen here in standard U.S. Army colours, “ANA Orange/Yellow” (FS13558) and “ANA True Blue” (FS 15102).

Note how much lighter “ANA True Blue” is compared to the thin vertical blue stripe on the rudder which is “Insignia Blue” (FS35044). This aeroplane is in French registry.

RCAF Harvard MK. II in overall “Trainer Yellow” sometimes called “Mustard Yellow” (approximately FS 13358) wearing the post-war RCAF Type-1 roundel with red “Maple Leaf” centre and RAF Type C tri-colour fin flash. During WWII and until 1946, RCAF aircraft wore typical RAF Type A- three colour, Type A1 - four colour, Type B - two colour roundels and fin flashes; although during the war, a few valiant, patriotic Canadian pilots unofficially “re-decorated” RAF tri-colour roundels on their aircraft by painting small red maple leaves on the RAF red centre circle.

Harvard II was the equivalent to the USAAF’s AT-6A and Harvard IIA was the equivalent to the USAAF’s AT-6C which differed from the Mk. II in that to save more than 1,200 lbs. of aluminium, its entire rear fuselage was constructed of plywood and low alloy steel instead of the Mk. II’s metal covered (not monocoque), light alloy tube construction. Harvard Mk. IIB was a variant of the Mk. II and was built by the Noorduyn Aircraft Company in Canada. In the U.S. this aircraft was known as AT-16. Harvard Mk. III was essentially identical to Mk.IIB but was constructed of all metal and had a 24 volt electrical system, probably to help start those P&W “Wasps” on frigid Canadian winter mornings.

Unusual photo of a BT-9 performing a roll over Randolph Field circa 1939.
Note the movable wing slats on the outer wing leading edges shown here to be extended. A wing slat is a section of the wing's leading edge which opens aerodynamically at high angles of attack (Alpha) to permit the oncoming air to flow more easily over the wing, delaying the stall and permitting the ailerons to continue to be effective. These slats were added after the original batch of factory BT-9s proved to be highly unstable at slow speeds and in the departed flight regime (stalls and spins) and it was hoped that these slats would tame this situation-- they did not.

Training Centers were opened, the Southeast Army Air Corps Training Center later renamed the Gulf Coast Army Air Corps Center at Maxwell Field near in Montgomery, Alabama and the West Coast Army Air Corps Training Center at Moffett Field near Sunnyvale, California. In 1942, the USAAF moved the West Coast Army Air Corps Training Center from Moffett Field to Santa Ana Army Air Base, in Santa Ana, California.

Primary training consisted of 60 hours flight training over the course of nine weeks and was the crucible in which new cadets were adjudged fit to continue further flight training. During this phase of training, each cadet was constantly tested and most carefully monitored so as to eliminate those who it was deemed could not pass the strict requirements of both ground school and flight instruction. In Primary, if a cadet exhibited an inability to learn to fly within a prescribed period of time and/or was seen to be developing poor judgement and/or habits, that cadet was not permitted to continue and was "washed out".

In Primary Training in all air forces, cadets were introduced to flying an aeroplane in its simplest and gentlest form: basic flight instruments, low horsepower, fixed undercarriage, fixed- pitch propeller, possibly not even a mixture control, no flaps or speed brakes, low takeoff and landing airspeeds, forgiving handling, gentle stalls and spins, etc. In addition to flight instruction, a cadet took many hours of ground school classes in a number of aviation- relevant subjects including basic math, physics, chemistry, aerodynamics, flight theory, engine operations, weather, military protocol, military and aviation history, and the like. It was in these rigorous classes that many cadets washed out.

During Primary phase of instruction, the cadet learned to fly straight and level on a particular course at a constant altitude, make coordinated turns, climb, glide, slow flight, departed flight regime (stall and spin recovery), basic engine operation, landing patterns, and takeoffs and landings. In Primary, the cadet was expected to become competent to fly solo within 10 to 15 hours of flight training and thereafter to practice what had been learned thus far in a practice area near the main airbase.

RAF

During WWII (commencing September 3, 1939 for Great Britain and December 7, 1941 for the United States) RAF and RCAF flight training was conducted either in the United States or Canada to avoid possible interruption of instruction by Luftwaffe attacks. RAF/RCAF Flight training was similar in every way to that of the USAAF except after 1940, when an additional four hour initial "weeding out" programme in Great Britain similar to the Pre-Flight stage of the USAAC and USN/USMC was instituted. During this initial programme, prospective cadets took instruction in newly available Tiger Moth biplanes for four hours to see if they were physically, mentally and emotionally fit for further flight instruction. Most modern air forces have since adopted a similar programme in which prospective flight cadets are "screened" for fitness to go further.

Aircraft used for Primary Training by all air forces in the 1930s were usually simple, low powered, two-place biplanes such as the Consolidated PT-11 and later the similar Boeing Stearman PT- 17 (U.S.), Avro 621 "Tutor" and later de

R. A. F. Avro - 621 “Tutor” Primary trainer in pre-war colours. In the 1930s, high visibility red and white wings and tail surfaces helped to prevent collisions and near misses in busy and crowded R. A. F. training field traffic patterns. After WWII began, RAF training aircraft were painted in Standard Day Camouflage of Dark Earth (approximately FS 30095) and Dark Green (approximately FS 34079) with under-surfaces from the fuselage mid-line down Trainer Yellow (FS 13358) - see the photo of the Miles “Magister” above. For safety purposes, the undersides were a high visibility yellow to help to avoid mid-airs and such. The top camo was, as usual, intended to obscure the aeroplane’s outline when on the ground.

Miles “Magister” RAF primary trainer in wartime colours.

Piper J-3 Primary Trainer in alternate USAAF observation aircraft colours, “Orange Yellow” fuselage, Silver painted wings and stabilizer/elevator and markings as it would have appeared in the late ‘30s and during early WWII.

Beautifully restored PT-19A Primary trainer in “Orange/Yellow” (FS13558) and “True Blue” (FS 15102).

Boeing PT-13 Stearmans - Randolph Field, Texas (USA) circa 1937.

Consolidated PT-11 in USAAC trainer colours and markings. Photo circa 1934.

Ryan PT-22 in mid- WWII "bare metal" and "ANA Orange Yellow". What is commonly called "bare metal" was, as seen here, actually the unpainted aluminium skin coated with a clear top coat to protect it. Many of the so-called "bare metal" finishes were actually aluminium-coloured paint with a clear top coat. A decent clear top coat was a necessity for aircraft that were to spend much of their time parked outdoors in the weather as well as all aircraft carrier- based aeroplanes.

Havilland "Tiger Moth" (GB),

Focke- Wulf FW-44 (Germany), Yokosuka K5Y "Willow" (Japan); or, low-power, two - place monoplanes such as the Piper "Cub", Ryan PT-22 or Fairchild PT-19 (U.S.), Miles "Magister" (GB).

BASIC FLIGHT TRAINING

During the next phase of training, called "Basic" the cadet flew more complex aircraft which had higher performance with less gentle and forgiving handling, more horsepower, flaps, an adjustable/constant- speed propeller and mixture control, more instruments including those used for navigation, and radios for both communication and navigation.

In the USAAC and USN/USMC during the 70 hours of flight training over nine weeks of Basic Training, cadets were introduced to longer distance flying, chart reading, navigation including dead reckoning (compass and timepiece), celestial and radio navigation (intercepting and flying along a low-frequency radio beam), basic weather report reading and analysis, use of the communications radio, night flying, rudimentary instrument flying, aerobatics (rolls, loops, etc.) and precision flying, formation flying, short and rough field operations, emergency procedures, basic use of armament (bombs, machine gun), and flying prescribed missions.

In the 1930s, Basic training in the USAAC and USN/USMC also consisted of many hours of appropriate ground school. Cadets entering Basic Training at the Air Force Training Centers experienced the jolting introduction of rigourous standard Army discipline which had not been a part of the civilian- run Primary Training schools.

Aircraft used in Basic Training in most air forces in the '30s were often most similar to the bi-planes used in Primary, sometimes with slightly more powerful engines. Towards the end of Basic Training, the RAF and some other air forces introduced the cadet to older, formerly first-line, operational aircraft. An exception to this was that, by 1936, the USAAC and USN/USMC were giving Basic training in the new, low-wing, fixed- undercarriage 400 hp North American BT-9, predecessor of AT-6, and by 1939, in the 450 hp Consolidated Vultee BT-13 "Vibrator" as well. These aircraft were the first purpose-built Basic trainers and were highly successful in transitioning cadets to more complex and powerful aircraft. This set the stage for the next and most revolutionary flight training curriculum and aeroplane, Advanced Flight Training in the North American AT-6 "Texan".

TRANSITIONAL OR OPERATIONAL FLIGHT TRAINING

During the 1930s, after passing Basic Flight Training the USAAC and USN/USMC flight cadet graduated, was commissioned a Second Lieutenant in the USAAC and USMC, and an Ensign in the USN. He was now considered to be a full-blown, certified Military Pilot. These new pilots were then assigned to an operational Group/Squadron where they learned to fly first-line aircraft. If he was assigned to a squadron that flew multi-engine aircraft, he received the required additional instruction there. In the U.S. air forces, it was generally considered that it took at least four months in Transitional Flight Training before a pilot was ready to serve in an active squadron.

This was not really as impractical as it may sound at a time when first-line operational aircraft in the USAAC and USN/USMC were still fixed-undercarriage biplanes and were neither so very much more sophisticated nor developed than the aircraft which had been flown in Basic training. However, as far more advanced, more complicated, more powerful and faster aircraft such as the British Hurricane

Luftwaffe Focke- Wulf FW- 44CVV Primary/Basic Trainer. Recent photo taken at an air show in Germany. All colours (Lichtgrau RLM63) and markings are accurate to the mid- to-late 1930'-s when this aeroplane was commonly used for Luftwaffe training; except for the elimination and replacement of the "Swastika", the NAZI[4] political marking on the vertical fin which would have appeared there from 26 February 1935 until the end of WWII in Europe. However, since then that symbol and others related to it may not be legally displayed in Austria or Germany and in some other European countries except under certain, very strict circumstances.

Imperial Japanese Navy (IJN) Primary/Basic trainer Yokosuka K5Y "Willow" circa 1935 looking very like an American Boeing "Stearman" painted all over in "Tou-ou-shoku" – a Japanese version of "Orange Yellow - Navy C1" for high in-air visibility.

North American Aviation advertisement featuring AT-6s "Texans" overhead. NAA did not apply much subtlety with regard to that name.

North American Aviation 1942 advertisement unblushingly taking its due share of credit for the successful Doolittle Raid. Drawings of AT-6s can be seen as well.

Here are a few of the very dramatic and beautifully rendered advertisements that North American Aviation published during World War II:

A very rare, restored Consolidated Vultee "Valiant" BT-13 Basic trainer used by both the USAAF and USN/USMC as SNV, which cadets and instructors nicknamed "Vibrator" for reasons we may just imagine. An unforgiving aeroplane, it was more than a handful for cadets coming up from the Stearmans, Piper Cubs and such that they flew in Primary. The "Vibrator" proved to be a fragile and overly enthusiastic aerobat and was eventually restricted from aerobatics, stalls and spins which rather limited it usefulness for Basic training. It was gradually replaced by the far better (but not perfectly) behaved and structurally sound BT-9/NJ-1 during WWII.

North American BT-9B with its fabric fuselage panels replaced with metal panels. This is a rare colour USAAC photo circa 1937. BT-9 was a predecessor to AT-6 and was a 400 hp Basic training aeroplane with a fixed- pitch propeller and fixed undercarriage. Seen here in pre- ANA True Blue and pre- ANA Yellow Orange or Yellow #4.

(1937) and Spitfire (1938), the German Messerschmitt 109 (1937), the Japanese Zero (1940), the American Seversky P-35 (1937), Curtiss P-36 and later P-40 (1938-40) were introduced, the traditional course consisting of Primary, Basic and Operational flight training that modern air forces had thus far provided proved to be inadequate.

As these faster, more powerful and more demanding first-line fighter aircraft became operational, the gap between Basic training and Operational Assignment became wider and wider. By the late '30s, the RAF had established Operational Training Units (OTUs) for the purpose of transitioning newly graduated Pilots to the latest first-line aircraft, and it was in these OTUs at that time that the aforesaid training gap became all- too- well recognized.

Although it became clear that an additional Advanced Training curriculum was now required to properly prepare cadets to fly new, faster and more powerful aircraft before assignment to an operational squadron, such a course was universally not available. Instead, newly graduated pilots were give extensive ground instruction in the Transition phase of their training to familiarise them with whatever aircraft their assigned squadron flew, and when deemed ready, were then sent up to fly the aeroplane for the first time — solo.

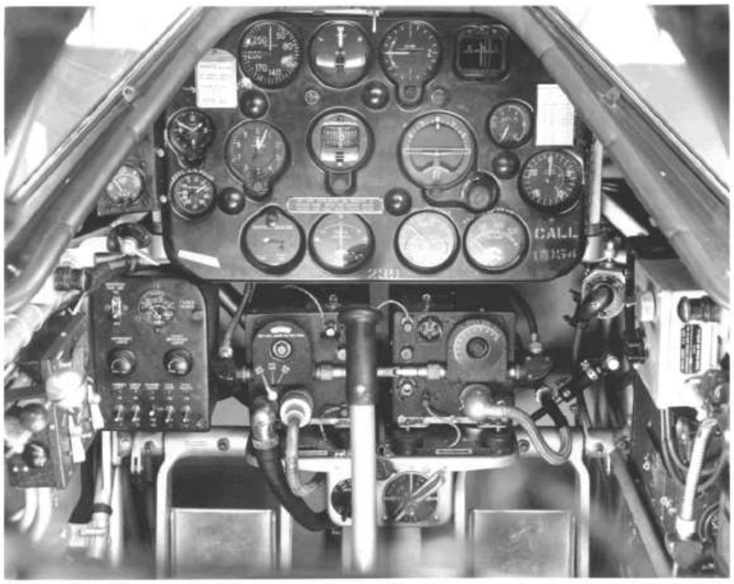
There was no dual instruction before solo in first-line fighters until much later, near the end of WWII when a few (at least five known) first-line combat aircraft such as P-51D "Mustang" were converted in the field at USAAF bases in Great Britain to two-seat combat trainers. After WWII, TF-51D, essentially a two-seat F-51 "Mustang" (the "P" for "Pursuit" designator changed to "F" for "Fighter" in 1948) with two full cockpits, was manufactured and many of them flew combat duty during the Korean War.

Also, near the end of WWII, Supermarine designed a two-seat Spitfire variant, T Mk. VIII for Operational Training duties, but only one of these was built (N32/G-AIDN) before the war ended and the RAF placed no orders. This did not prevent inventive RAF aircraftsmen from converting a few Spitfires to two-seaters in the field much as was done in the USAAF. After the war, a handful of converted Mk. IXs were built and sold to European and Commonwealth air forces.

Imagine having graduated from flight school and commissioned a brand-spanking new Second Lieutenant never having flown anything more sophisticated or capable than a fixed-undercarriage, fixed- pitch propeller 400 HP, 4,470 lb., 148 mph. BT-9 or BT-14 and then, the day or so after graduation, with no dual instruction, being expected to fly a retractable- undercarriage, 1,040 HP, 7,326 lb. gross wt., 352 mph P- 40 — solo. Naturally this procedure produced a great number of tragically foreseeable and preventable training accidents both on the ground and in the air.

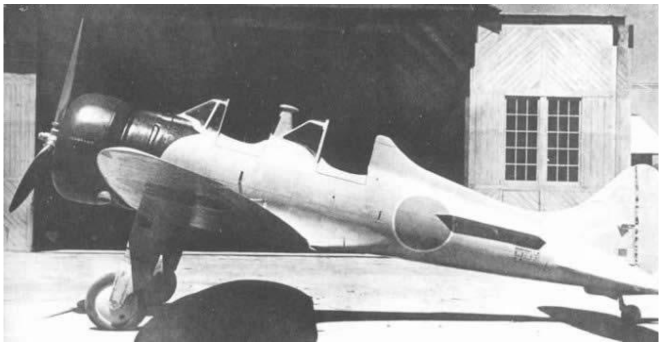
Before 1940, the concept of a distinct Advanced Flight Training course was universally entirely unknown and then only in the U.S. and shortly thereafter in the RAF and RCAF. In order to narrow the widening gap between the existing Basic Flight Training curriculum with flight training in the fixed-undercarriage, 400 hp BT-9 (and later in the slightly improved BT-14) and operational squadron assignment to greatly advanced first-line aircraft, a four-level (Primary, Basic, Advanced, Operational) graduated step-up military training program was commenced in the United States air forces just prior to World War II. Shortly afterwards this was adopted by the RAF, the Fleet Air Arm (FAA) and the RCAF while still maintaining Operational Training Units.

These Advanced Flight Training curricula were the vast exception with regard to all of the air forces of the other modern military nations including those of the Axis. Whilst the Luftwaffe operated a few advanced training aircraft types in the mid- 40'-s, a formal Advanced Training curriculum did not exist in Germany before and in the first years of the



BT-9 front cockpit and instrument panel. Photo circa 1936.
As a youth I made a full sized drawing of this very photo which I used to tape to my desk in my room and pretend to fly with it. I imagined all of the instruments moving and vibrating as I moved my baseball bat control stick. It was my very first "flight simulator" of a sort. Of course, I couldn't imagine then how far flight simulation would come from that to what we have now.

Korean War era TF-51D, two- seat Mustang. These can be easily distinguished from single seat F-51Ds by the elongated, raised bubble canopy to give the rear-seater a little headroom.



A5M4-K "Claude" two-seat trainer, an improvement over Japanese biplane trainers but still not nearly up to the performance of the A6M "Zero" or other first-line Japanese fighters. of its time.

Two-seat Spitfire Mk. IX. The instructor sits behind and slightly above the student up front. This arrangement wreaked havoc with the Spitfire IX's center of gravity moving it far aft causing the usual concurrent instability at lower airspeeds. Accordingly, intentional stalls and spins were prohibited.

Not being able to find any photos of A6M2-K two-seat Zero trainer, this is a photo of an excellently built and finished scale model of this aeroplane.

war. From the middle to late -'30s and well into the 1940s, a distinct Advanced Training programme was also not a part of the flight training curriculum of the air forces of France, Italy or Japan. This proved to be a fatal omission.

After 1942, the Imperial Japanese Navy (IJN) instituted something like an Advanced flight training curriculum primarily incorporating the Mitsubishi A5M4-K, a specially built, two-seat version of their former first-line and first monoplane fighter, the Mitsubishi A5M - Type 96 "Claude", sometimes called "Sandy". This trainer was a vast improvement over the series of low-powered biplane trainers such as the Yokosuka K5Y "Willow" (see above) that had previously been used to train Japanese pilots; however, the two-seat Type 96 was still far less complex and capable than the first-line aircraft which were then in combat. In late 1943, a two-seat trainer variant of the A6M "Zero" was built to aid in training replacement pilots for the IJN. Many different versions of this aeroplane were built in an effort to improve its aerodynamic performance, particularly with regard to stall and spin maneouvers which, as with the two-seat Spitfire (see above), were not at all predictable with the aeroplane's aft centre of gravity. A6M2-K was a reasonably successful and effective trainer; however, it came too late to make any difference in what was by then a lost war.

HOW ADVANCED FLIGHT TRAINING (AND THE LACK OF IT) HELPED THE ALLIES TO WIN THE WAR IN THE PACIFIC

The Japanese military pilot training programme was second to none in the 1930s, but still included nothing similar to a distinct Advanced flight training curriculum. Very rigourous and often brutal Flight training was available to only the very top physical and mental candidates and, accordingly, very few pilots entered Japanese military flight school before WWII. Of these few a great many washed out and only the most highly exceptional graduates were assigned to squadron duty. These very well-trained and talented pilots were the true elite and they manned the rolls of Japanese fighter and bomber pilots in 1937 when Japan began its war with China. By the time Japan was at war with the Unites States and its Allies, these superior and formidable pilots had already had a good deal of experience in combat, albeit exclusively with inferior Chinese air forces and aircraft.

After December 7, 1941, pilots of the U.S. and Commonwealth air forces were confronted by these very specially talented and experienced pilots, many flying the excellent Mitsubishi A6M

Curtiss P-40 B in pre and early - war colours: "Olive Drab 41" (FS 34088 or 34036) on upper surfaces and "Neutral Grey 43} (approximately FS 36173 - allegedly 50% black and 50% white) on under surfaces. The actual Neutral Grey (as seen here) was a very dark grey of a similar gradation as Olive Drab so as not to create a strong contrast between the two colours. Too often restored airshow aircraft are painted in a much lighter colour below, usually something closer to Sky or Light Grey (FS 36440) which was not an official underside camouflage colour when the upper surfaces were Olive Drab 41. National markings are the early white star with red centre circle. The red circle was removed in May 1942 so as not to be confused in the swirl of aerial combat with the Imperial Japanese aircraft insignia, a large red circle (Nisshōki, or more commonly, Hinomaru – the sign of the sun).

P-40B was the USAAC's first- line fighter in 1940- 42 and the aeroplane that Army flight training graduates flew immediately upon operational assignment. A much heftier, more complex, faster and more powerful aeroplane than a BT-9/14 Basic Trainer, it's fortunate that there was an Advanced Training course in the AT-6 which in every way is far closer to the P-40.

P-40 suffered from its Allison V-1710 engine having no turbo or supercharger and thus was fairly anaemic above 15,000 feet. In the European Theatre this was a fatal handicap where combat often commenced as high as 35,000 feet. In the Pacific Theatre where combat usually commenced below 15,000 feet, P-40 was able to use its high airspeed, excellent firepower and rugged airframe to fight and triumph over Japanese fighters.

"Zero"[5]. They initially had a hard go of it suffering terrible losses in the air. Fortunately, their Advanced Flight Training had given them an excellent and comprehensive flight education before they were sent to combat duty, and despite these great losses, they were able to hold their own until the IJN and its air force were soundly defeated at Midway between 3 and 7 June 1942. As a result of the maximum efforts of the valiant pilots of the USN/USMC and Commonwealth air forces up to and in the Battle of Midway, the IJN lost a good many of those elite pilots with which it had so boldly and audaciously commenced the war.

By June 1942, the air forces of the U.S. and of the Commonwealth nations had also lost a good many excellent pilots, but they had the great advantage of the Japanese air forces in that hundreds of well-trained pilots were ready to replace the fallen, all of whom had undergone Advanced Flight Training.

As for the Japanese, with no similar Advanced flight training programme on hand, those pilots who were rushed through flight school to replace those few aforementioned especially skilled but now fallen pilots were vastly undertrained and unable to adequately fill their shoes. Accordingly, the balance of air power superiority in the Pacific, essential in order to insure the success of the ever- encroaching island invasions and the liberation of Japanese - held territory which eventually led to Allied victory, shifted to the Allies and was never thereafter relinquished.

Additionally, Japanese Navy and Army pilots did not rotate out of combat after a certain number of missions had been flown as was the practice in the Allied air forces. According to the Bushido, the Code of the Samurai, Japanese pilots were expected to serve until the war was over or they were killed. Thus, many otherwise superb Japanese pilots simply became exhausted over the war years whilst Allied air forces were continually refreshed with well-trained replacements. Even severely wounded Japanese pilots often re-entered combat before they were fully healed or, in some cases having actually lost an eye or a limb in combat. A superb narrative of WWII era Japanese Navy pilot training and combat service during the war may be found in the fascinating "Samurai!" by Saburo Sakai and Martin Caiden.

IN EUROPE

A similar situation to that of the Japanese air forces obtained in Germany where excellent Luftwaffe flight training was available prior to the war, but only to a relative few as there

Rare, restored, flyable P-39 "Airacobra". This aeroplane came into USAAC service in 1941 to supplement P-40. Unlike P-40, it was generally not well-liked and did not fare nearly as well against the Japanese air forces. It's Allison V-1710 was the same engine as in the P-40 suffering the same lack of a supercharger or a turbo charger. P-39 was similarly handicapped at altitudes higher than 15,000 feet, making it next to useless for typically high- altitude European Theatre combat. An agile and fast fighter, it was very well armed with two nose mounted Browning 0.50 in (12.7 mm) machine guns, four 0.303 in (7.7 mm) Browning machine guns in the wings and a 37 mm cannon firing through the propeller shaft as in BF-109E. Many pilots found that the combination of three different sized guns in P-39 made it difficult to pinpoint a target for all of them simultaneously as they had different muzzle velocities, trajectories and rates of fire. However, many Airacobras were sent to the Soviet Union where its brute punch was very well appreciated and where it did very good service (at low altitude to be sure) against the Luftwaffe.

USAAC flight school graduates were given rudimentary ground- only instruction in this first- line aeroplane and were expected to fly it solo very shortly after operational assignment. Without a good, solid Advanced Training course and many hours in an AT-6, this surely would have proven to be a somewhat hazardous exercise. This particular P-39 exhibits the later-war U.S. insignia the "stars and bars" adopted in September 1943.

was, amazingly, only one Luftwaffe pilot training school in Germany until 1944 providing nothing similar to an Advanced flight training curriculum. The Luftwaffe began World War II with a good supply of experienced pilots who had gained their skills regarding the finer points of military flying over the many years and flying hours that they accumulated at leisure during the decade of peace before the war. Beyond the basic knowledge required to fly and operate their countries' military aircraft, they were essentially self-taught in aircraft that were largely obsolete for combat in the War to come. The fact is that neither Nazi Germany nor the Empire of Japan had instituted a comprehensive Advanced course of training for combat pilots, nor did they possess an aeroplane capable for that purpose (except for the AT-6s which the Nazis captured during the occupation of France, only a small number of which were ultimately used for training purposes).

Accordingly, once the war began the Luftwaffe was initially able to reap the reward of their relatively few experienced combat pilots' long peacetime training and combat experience in the Spanish Civil War (17 July 1936 - 1 April 1939). These pilots famously scored many early aerial victories; however, as the war progressed and more and more of these veteran pilots were killed, seriously wounded, or captured, their replacements, no longer having the luxury to train in pre-war style leisure were mostly over-matched by better-trained Allied pilots. Additionally, as the war progressed and more replacements were needed, the Luftwaffe flight school curriculum was ever shortened. After a few short weeks and too- few actual flying hours and it was "Bam, into combat you go, me lad"; or perhaps rather,. " Bam, in den Kampf gehen Sie, mein Junge!"

For a number of reasons, not the least being that there were simply so few qualified replacement pilots available, German pilots, like their Japanese counterparts, were not rotated after a certain number of missions and were expected to serve until the war was over or they were severely wounded, killed, or captured. As with the Japanese air forces, once the war commenced there was no time nor were there any established facilities in which to train replacement pilots to the required level of expertise. Accordingly, as the war progressed, Luftwaffe replacement pilots were too often unable to effectively match far better trained Allied pilots who, unlike the Luftwaffe pilot replacements, had Advanced flight training before going into combat.

By the 1930s the French air force, Armée de l'air (literally "Army of the Air") was entirely undermanned and

Grumman F4F "Wildcat" in pre and early - war colours: Blue- Grey (FS 35189) on upper surfaces and Light Grey (FS 36440) on under surfaces (only slightly visible here).

F4F was the U.S. Navy's first-line fighter in 1940- 43 along with the far less-capable Brewster F2A "Buffalo". Until Grumman F6F "Hellcat" went into service in early 1943. "Wildcat" was what USN/USMC flight school graduates would fly immediately upon operational assignment.

"Wildcat" is reputed to be one of the finest handling and most maneouverable U.S. Navy fighters of WWII which, along with its great structural integrity and firepower may be why it was able to better than hold its own for two years against the formidable Japanese A6M "Zero". Wildcat's kill ratio (cheers Darryl) was 5.08 to 1 - not as good as F6F "Hellcat" at 19.12 to 1, but still respectable.

It might well be noted that in the earliest months of U.S. Pacific theatre operations, the IJN still counted amongst its cadre a good number of the very best fighter pilots in the world, flying the startlingly able Mitsubishi "Zero". This may largely account for Wildcat's moderate performance in combat.

Not withstanding Hellcat's formidable ability, by the time that Hellcat and its excellently- trained pilots came into operation, a good many of the best IJN pilots had been killed or seriously injured. That they were not replaced by pilots of anything close to equal quality may account in good measure for Hellcat's stellar record.

under-equipped to fight a modern, mid- 20th century air war. Ironically, France had been one of the most effective and successful air powers in the 1st World War; however, as did many nations during the 1920s and 30s, Armée de l'air was bureaucratically and politically diminished until by 1939 it was a scant shadow of its former self. Similar to the Luftwaffe and Japanese air forces, Armée de l'air maintained few training facilities and also made no provision for an Advanced training course. French military pilots were expected to learn to fly their few first-line combat aircraft after assignment to a squadron. When the war commenced, those few who had gone as far as that were quickly lost to the overwhelming air power of the Luftwaffe.

THE THEORY OF ADVANCED FLIGHT TRAINING

As logical a concept as advanced pilot training may seem to be it was, as mentioned, not a part of the training syllabus of any of the air forces that participated in World War II with the exception of the United States and soon after adopted by Great Britain and Canada. Additionally, the Allies were uniquely blessed with a purpose-built aeroplane, the North American AT-6, in which such Advanced flight training was given.

The concept and institution of an Advanced stage in pilot training was based upon the realisation in the U.S. military air forces, at end of the 1930s, that in the likely event that the United States became involved in the World War in Europe (that had begun on 1 September 1939) the war effort would be best served if there was a steady stream of combat-ready pilots to replace those who had fallen, and as well as to maintain and increase the number of such pilots.

As mentioned before, the ever- widening gap between aircraft used for Basic flight training and first- line combat aircraft made it an imperative to add an additional stage of flight training after Basic to be flown in a more capable aeroplane that was closer in weight, systems, power and handling to that which was then being or about to be flown in combat.

The planned curriculum in the USAAC-F and USN/USMC Advanced training course would essentially bring together everything that the cadet had already learned and push it up quite a few notches. Flying an aeroplane with the same systems, instruments and feel of a first-line fighter would be invaluable to a cadet and would make his transition into Warhawks, Airacobras and Wildcats a safer and more seamless operation. In Advanced the planning and completion of

A pair of Grumman F6F "Hellcat"s. Photo circa 1943. Seen here in mid-war (1943-late 1944) USN/USMC tri-colour camouflage of 607 Non-Specular (matte) Sea Blue (FS 35042 or 35045) on all upper surfaces and top of fuselage down to around the mid-point; ANA 608 Non-Specular Intermediate Blue (FS 35164) on vertical surfaces and across mid-fuselage to wing/fuselage attachment point, also on underside of outer wing panels which fold upwards such as F4U "Corsair"; and ANA 601 Non -Specular Insignia White (FS 37880) on undersides of horizontal surfaces and below wing/fuselage attachment point. Hellcat's wings fold back along side of the fuselage (blue side out), accordingly its entire wing undersides are painted Insignia White. (Seen in this light looking rather blue-ish).

The red-outlined national insignia seen here was adopted in all U.S. air forces from 28 June 1942 - 14 September 1943.

Hellcat is Wildcat's younger, though much larger brother. An entirely new design, it was intended to remedy the faults that Wildcat demonstrated when fighting the IJN "Zero". Powered by a 2,000 hp Pratt & Whitney R-2800, which is the same engine used which powered both the USAAF P-47 "Thunderbolt" and the USN/USMC F4U "Corsair". Hellcat has the largest wing area of any Allied single-engine fighter to aid it in fighting the "Zero". This, combined with all of that power made Hellcat faster, a better climber and an almost equal dogfighter to the "Zero".

complex missions of all kinds and over greater and greater distances would be emphasised as well as further formation, instrument, poor weather and night flying. Mock combat, aerial and air- to- ground gunnery and bombing would also be a large part of the course. The concept and theory was that, by the time that a cadet was ready to graduate from Advanced, he would be as well-trained a military pilot as possible. Of course, the prime element required to effectively bring the cadet up to this point of readiness was a trainer that would be reasonably challenging but not so much so that it might be hazardous for the cadet to master. Nothing of this kind existed in the 1930s; however, with the new decade that would soon be rectified.

AN ADVANCED TRAINING AEROPLANE

As mentioned, an Advanced Trainer is the last aeroplane that a military pilot will fly before assignment to an operational squadron. The closer it is in weight, flight handling, and systems operations to first-line aircraft the better. Therefore, its flying qualities, instrumentation, systems, etc. must be designed to be very like, if not identical (except for horsepower) to that of the first-line operational aircraft that the pilot is likely to be assigned to fly after graduation. Of course, even after Advanced training school there would be a period of familiarization with the type of aircraft that the squadron to which the pilot had been assigned was flying; however, as mentioned, until very near the end of the war and only in a very rare and few instances were there two-seat versions of these aircraft in which final operational training may be given. Newly assigned military pilots were essentially on their own to learn the ways of first-line operational aeroplanes. Accordingly, it was recognised in the USAAC and USN/USMC that it was all well and good to provide an Advanced flight training course; but, without a purpose-built Advanced trainer suited for this course, it would be impossible to bring the cadet up as close to first-line fighters was desired and required.

GREAT THINGS FROM HUMBLE BEGINNINGS

This adage has never been truer than with regard to so many of the great aircraft which so often evolve and are the more finely developed product of their earlier, earnestly conceived but flawed and/or limited ancestors. In this the North American AT-6 is no exception.

From its inception as an aircraft designing and manufacturing company, NAA has had an exceptionally felicitous ability to create aeroplanes that are the archetypes of their kind.

Founded in 1926 by Clement Melville Keys as a holding company which owned many small aviation companies and

WWII era photograph of Brewster F2A “Buffalo” in the same colours as F4F “Wildcat” seen above. Note the absence of the red centre circle which was removed from all U.S. aircraft insignia in May 1942.
This is a good photo angle for the ungainly “Buffalo” which looks here much like an NAA P-64 (see below).
“Buffalo” was flown by the USN/USMC and was operational in the air forces of Australia, New Zealand, Finland, Belgium, Great Britain, and Holland.
Fast for its time and reputedly very maneouverable in its original factory condition, after the addition of heavy required military equipment, armour, and armament, its weight became so greatly increased that performance greatly suffered. In the first year of the war (1942) “Buffalo” shared first-line duty with “Wildcat”; however, it fared very badly against the Japanese air forces. In the great aerial battle at Midway which commenced on 4 June 1942, of the 19 Marine F2A-3 “Buffalos” participating only 3 survived. After that it was withdrawn from duty as a USN/USMC first- line fighter, leaving that role to Grumman F4F “Wildcat”, Chance Vought F4U “Corsair” and later also to Grumman F6F “Hellcat”.
Col. Gregory “Pappy” Boyington, of the U.S. Marine Corps, flew early versions of the “Buffalo” and observed: “...but the early models, before they weighed it all down with armour plate, radios, and other [equipment], they were pretty sweet little ships. Not real fast, but the little bastard could turn and roll in a phone booth”.

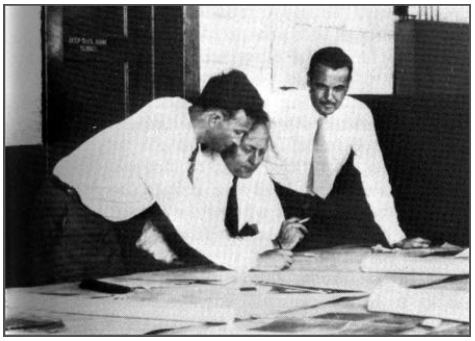
1941 photograph of a North American B-25B, with red centre circle markings. This particular B-25B was piloted by Lieutenant Colonel James “Jimmy” Doolittle, USAAC on the “Doolittle Raid” which consisted of sixteen B-25’s taking off from the USS Hornet aircraft carrier (the only USAAC-F medium bomber type ever to do so in combat and believed by many to be the only one capable of doing so) on 18 April 1942 to bomb Japanese cities.

Restored North American A-36 “Apache” fighter-bomber. Note the speed/dive brakes on the upper and lower surface of the wing that were unique to this variant. The immediate predecessor to the P -51, “Apache’s” Allison engine was un-supercharged and therefore the aeroplane could not adequately perform above 15,000 feet. However, upon a complete re-design and the installation of a supercharged Rolls-Royce “Merlin” engine, the same engine installed in the “Spitfire” and “Hurricane”, the P-51 was transformed into what many consider to be the finest fighter of WWII. The insignia on this aeroplane is the short-lived, red-outlined stars and bars, which appeared only from 28 June 1942 - 14 September 1943.

P-51B. This was the earliest “Mustang” to see combat and was the fastest of all the “Mustang” variants during WWII. The bubble canopy of the “D” model, whilst granting excellent 360 degrees visibility, created a good deal of drag as opposed to the more aerodynamically efficient fastback “B” variant. This is a WWII era photograph taken at March Field, Riverside County, California in which the colours are unusually excellent and accurate. This “Mustang” is seen here in “ANA Olive Drab 41” and “ANA Neutral Grey”.

AT-6D in “ANA True Blue” and “ANA Orange Yellow” with pre - early war red circle insignia.

Later model maquerading as an earlier SNJ-2, the U.S. Navy's and Marine Corps' version of the AT-6. Note the three-blade propeller (Very few T-6 variants had three bladed props, the first being the BC-2). In the pre- and early-WWII era U.S. Navy training aircraft were painted as seen here: fuselage - light grey (unspecified) or silver, underneath wings - silver paint or clear coated metal, wing tops - "ANA Orange Yellow", all other colours and markings indicate group, squadron and flight assignment.



left to right - John Leland (Lee) Atwood, James H. "Dutch" Kindelberger and Stanley Smithson going over the final drawings for NA-16 on 30 May 1935.

airlines, it was broken into smaller independent components by the "Air Mail Act of 1934". General Motors (GM) snapped up the aircraft designing portion of NAA in 1933 combining it with their General Aviation Division. However, GM saw the necessity and potential of creating and maintaining a separate aircraft manufacturing company and recruited (stole?) aeronautical engineers par excellence James H. "Dutch" Kindelberger and John Leland (Lee) Atwood from the Douglas Aircraft Company, retaining the original name of "North American Aviation". Thus 1934 saw the emergence of the "new" NAA that was to produce so many great aeroplanes.

Examples of these are B-25 "Mitchell" (operational in the USAAF in early 1942),

A-36 "Apache" (operational in the RAF in February and in the USAAF in April 1943),

P-51 "Mustang" (operational in the USAAF in late 1943) and no less than these, AT-6 "Texan" (operational in the USAAF from early 1940). North American Aviation's current successor through merger is Rockwell International and its aircraft division is called "North American Aircraft Operations".

One of the first things that "Dutch" Kindelberger and Lee Atwood did when they came to

NAA in early 1935 was to put together a team of engineers and pilots to create the first NAA aeroplane; a Basic military trainer. NAA had big plans for this aeroplane both with regard to U.S. military air forces and to those of foreign nations. NAA's officers understood that air forces world-wide had a long-unsatisfied requirement for a modern trainer and they were bound to deliver it.

In the spring of 1935, they went to work along with NAA chief draughtsman, Stanley Smithson and test pilot Eddie Allen and began to draw what would become NA-16/BT-9 Basic trainer.

Combining what they knew to be good and sound aeronautical engineering up to that time, along with a few new and fresh ideas, they came up with a practical and easy to maintain design that would accommodate an instructor and student in open tandem cockpits. Virtually all military aircraft up until late 1935 had open cockpits. Pilots liked this because it allowed them to hear and feel the wind and it helped them feel closer to the aeroplane in general. When asked, military pilots always informed aircraft designers of this preference.

Open cockpits might have been fine in 1935, at a time when the USAAC's P-12E's maximum airspeed was 189 mph; the P-6E, the last Army biplane fighter had a maximum speed of 205 mph; the all-metal monoplane Boeing P-26A, the latest Army fighter, could achieve 234 mph; and the USN/USMC's first line fighter, the Grumman FF-1's maximum speed was 207 mph. However, aviation technology was rapidly advancing and would soon make these aeroplanes seem to be not only old-fashioned and quaint, but in fact, highly obsolete.

After a prototype of the first version of the NA-16 was submitted to and accepted by the USAAC in the Spring of 1935, the Army asked NAA to add two features: an enclosed cockpit and faired undercarriage legs. The faired undercarriage legs were primarily for preventive maintenance as they kept dust, dirt and mud from clogging and interfering with the undercarriage's oleo strut mechanism, and only secondarily for clean aerodynamic reasons. An enclosed cockpit was desired as it would permit training to be carried out in all weather and climates and also provide pilots with experience flying in a sheltered environment. While the first fully- operational USAAC fighter with an enclosed cockpit, the Seversky P-35, the immediate predecessor of the P-47 "Thunderbolt", would not arrive until 1937, by 1935[6] it was understood in knowledgeable aviation circles that as aircraft performance was continually increasing an enclosed cockpit was becoming necessary.

A revolutionary year in aviation by any measure, between mid-1935 and mid-1936 the Luftwaffe (Messerschmitt BF-109- May 1935) and RAF (Hawker "Hurricane" - November 1935 and Supermarine "Spitfire" - March 1936) introduced the next generation of fighter aircraft. These were truly game-changers which threw everything that had come before into the dustbin of history. These aeroplanes all had

Boeing P-26B was USAAC's first- line fighter until 1938. It was the first monoplane fighter of any U.S. military service and had a top speed of 234 mph. It was nick-named "The Pea Shooter" for the two machine gun extension tubes that passed through the fuselage and out the front of the cowling (not seen here).
The fuselage (under all of those flamboyant squadron markings) is gloss Olive Drab 22 (approximately FS 10017) a true dark olive paint colour and quite different from the WWII era matte Olive Drab 41. The top and bottom of the wings and horizontal tail surfaces are Yellow #4. (approximately FS 13538)

Looking more like a sport or racing aeroplane than a first-line USAAC fighter, this Boeing
P-26B is seen here in Light Blue 23 (approximately FS 15193) which replaced Olive Drab 22 after the official colour change order for all USAAC aircraft in May 1934. This colour is an almost turquoise blue version of "Light Blue" and much lighter than the more often and later used "True Blue". It seems to be very close to the paint chip of this colour which appears in a number of "authoritative" publications.
Apparently there were many "Light Blues" used for USAAC aircraft finishes after May 1934. Some were almost as dark as True Blue and some were somewhere in between the lightest and darkest hues of this elusive colour. Aircraft restorers and museums definitely do not agree as to exactly what "Light Blue" actually looked like and accordingly P-26As and other aircraft of this era appear in museums in just about every possible shade of blue.
While USN/USMC aircraft certainly showed a colourful array in the '30s, nothing ever beat the USAAC P-26As for its stunning, flamboyant appearance.

1935 photo of the prototype NA-16 as it was first presented to the USAAC. Note the open cockpits and unfaired undercarriage. This is the first and the progenitor of the long line of aircraft ending with the T-6G.

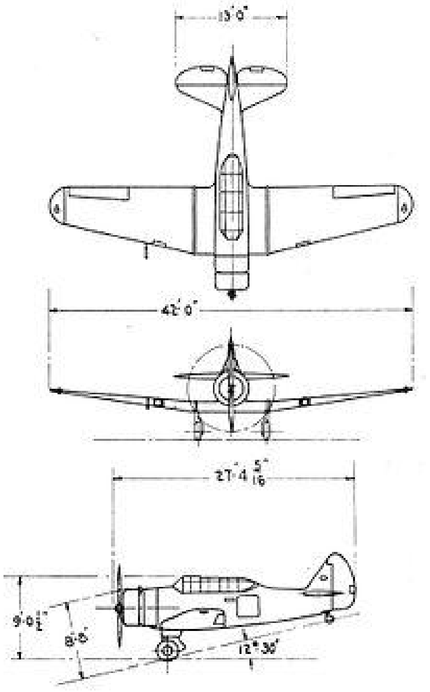
After the Army's "suggested" modifications were installed - an enclosed cockpit and faired undercarriage - the aeroplane was designated NA-18, shown here in USAAC colours but with civilian markings. Note the early- style corrugated metal covered vertical fin which was also the same on the horizontal stabiliser.

enclosed cockpits, were all- metal (except "Hurricane"), and had retractable undercarriages. Also, and not at all least, they all had maximum airspeeds of 340+ mph. While it would take a few more years for these aeroplanes to become fully operational in their respective air forces, there was no question in the minds of anyone who was paying attention that they were the future and that open cockpit, fixed- undercarriage fighter aircraft were a thing of the past.

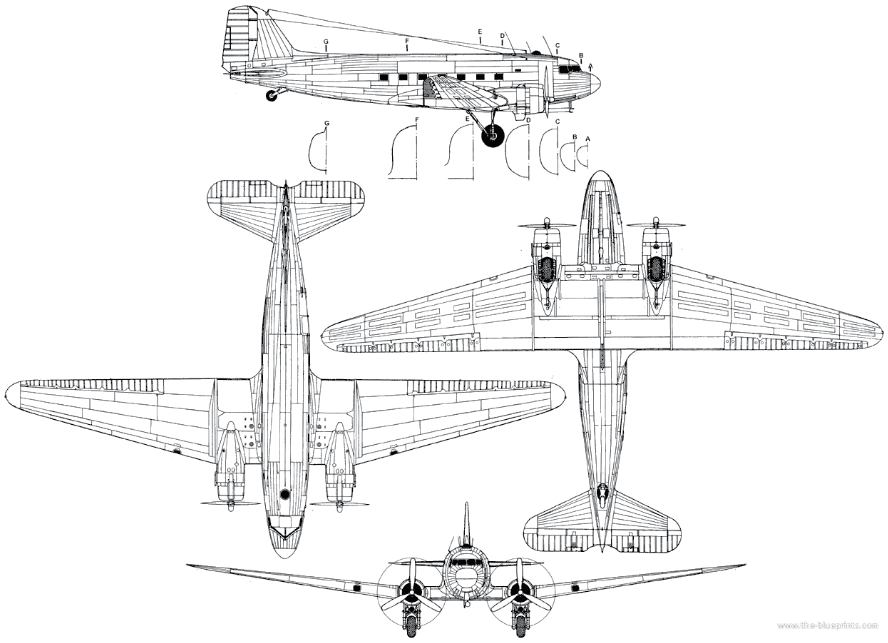
Because NA-16 was to be a Basic trainer, it was kept as simple as possible to operate. When NA-16 was designed, the USAAC's first-line fighter, P-26B, had a fixed undercarriage. The USAAC's first retractable undercarriage fighter, Seversky P-35, would not become operational until May 1937. Accordingly, and for these reasons, NA-16's undercarriage was designed to be fixed as well as was the propeller's pitch. Power was to be the excellent 400 hp Wright R- 975-53 radial engine, which would give the new trainer good but not overwhelming power for a Basic training cadet. As it was initially designed, NA-16 was the most powerful Basic training aircraft in its time and for that and for its other atributes, most heartily welcomed by the U.S. military air forces.

DESIGN INFLUENCES

Lee Atwood and James "Dutch" Kindelberger met in 1930 while working as young engineers at Douglas Aviation. "Dutch" was soon promoted to Vice President of Engineering and was put in charge of the DC-1/DC-2 project with Atwood as chief engineer. This aeroplane eventually became DC-3/C-47/Dakota, one of the Allies' most valuable assets in WWII and which has been highly credited by no less than President



NA-16 3-view showing the wing's planform.



DC-2 3-view showing the wing's planform.

(General) Dwight D. Eisenhower who called C-47, along with the bulldozer, the jeep, and the 2½ ton truck, one of the pieces of equipment "most vital to our success" in Africa and Europe.

Kindelberger and Atwood, bringing their combined formidable aeronautical engineering expertise acquired at Douglas Aviation to bear upon their first design for NAA, took DC-2's basic wing shape and reduced it in size for NA-16. The distinctive constant- chord centre section, straight trailing edge and the swept-back leading edges of the outer wing panels which provide a self-damping, inherent roll stabilizing force similar to dihedral, desirable in both transport and Basic training aircraft[7] was liberally "borrowed" from DC-2.

DC-2 Wingspan: 85 ft. 0 in. (25.9 m.), Wing area: 940 sq. ft. (87.3 sq. m.)

NA-16 Wingspan: 42 ft. (13 m.), Wing area 241.67 (22.47 sq. m.)

Not only did Kindelberger and Atwood "borrow" DC-2's wing planform, but they also used its exact same airfoil ordinates — NACA 2215 at the wing root and NACA 2209 at the wing tip. These were airfoils that they were familiar with and which performed well on DC-2.

Another feature of the NA-16's wing which was borrowed from the DC-2 and also the Northrop "Gamma" and which was carried over to all subsequent NA-16 variants is the flat, heavily framed, constant-chord centre-section which contains fuel cells and undercarriage attachment points and mechanisms. The outer wing panels are easily detachable from the centre section. This became a very useful and convenient repair/replacement feature when, as it happened from time- to- time, flight cadets ground-looped upon landing, causing wing and wing-tip damage.

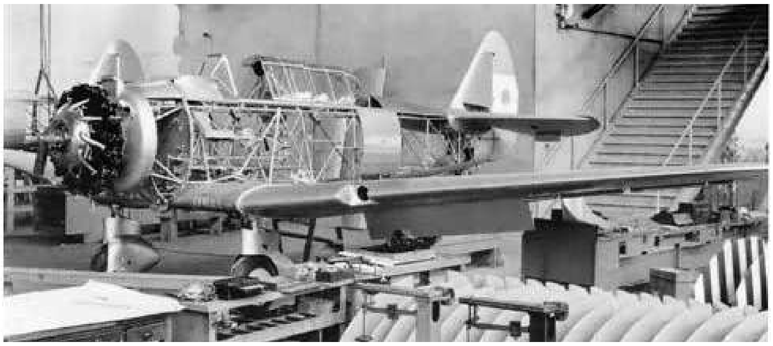
Additionally, Kindelberger and Atwood provided the NA-16 with numerous removable panels for easy maintenance and inspection. The sides of the fuselage have fabric- covered removable panels in the first versions, but as the aeroplane was developed these were replaced by aluminium panels. In some places the aluminium panelled NA-16 and its prodigy have been described as being "monocoque" or "stressed skinned", that is, that the outer skin provides the fuselage's primary structural strength; however, this is not the case. All NA-16 variants, including AT-6, have fuselages constructed of steel tubes which provide all of their structural integrity; the removable aluminium panels merely provide a streamlining covering for this structure and carry no load whatsoever.

At first, NA-16s were built at North American's General Aviation Manufacturing Corp., located at the Curtiss-Caproni plant at Dundalk, Maryland and was later produced at the North American plant in Los Angeles, California. From its very first conception, NAA intended the NA-16 series to be

American Airlines DC-2. Photo circa 1935.

USAAC BT-9. Photo circa 1937.

1932 Northrop "Gamma"



NA-18 showing steel tubular under-structure with the aluminium panels removed for maintenance.

One of the last and very few flyable restored NA-64 RAF “Yale 1s”.

sold internationally as well as to the U.S. military. They envisioned five different models that they hoped would suit foreign governments:

1. An all- purpose 2 seat trainer - NA-16-1/Harvard I
2. A 2 seat fighter/bomber - NA-16-2 - produced in Australia under licence to the Commonwealth Aircraft Corporation as CAC "Wirraway".
3. A 2- seat light bomber/attack aircraft- NA-16-3. This variant is the NA-16 series' first aircraft with a retractable undercarriage (NA-26) and leads directly to NA-59/AT-6. After a return to a fixed undercarriage, replacement of the fuselage's fabric removable panels with aluminium panels, NA-26 became NA- 44/ BT-14, the last fixed- undercarriage NA-16 variant.
4. A Basic trainer for the USAAC (BT-9) and USN/USMC (NJ-1) - NA-16-4, NA-19. This model was produced in the largest numbers of any early fixed- undercarriage NA-16 variant. In time, BT-9's fuselage would be lengthened becoming NA-64 "Yale 1", a Basic trainer very like BT-9 produced for and licensed to the RAF and RCAF.
5. A single seat fighter- NA-16-5/ - built for export in 1939 as NA-50 for the Chilean Air Force (Fuerza Aérea de Chile), as"Torito" (Little Bull) for the Peruvian Air Force (Fuerza Aérea del Perú) and domestically as NA-68, the USAAC's P-64.

P-64's rear fuselage was completely re-designed. Underarmed and underpowered for its time, with only two .30 in (7.62 mm) M1919 Browning machine guns, and an 840 hp (626 kW) Wright R-1820-G3 radial air-cooled engine, P-64 could reach a top speed of only 295 mph at just under 10,000'. It was certainly no match for contemporary European fighters. NA P-64 is virtually unknown today; however it compared well with Curtiss P-36 which had a slightly more powerful 1,050 hp (783 kW) Pratt & Whitney R-1830-17 Twin Wasp air-cooled radial piston engine, giving the Curtiss a top sped of 315 mph at 10,000'.

All together 34 variants of NA-16 were produced and sold world-wide. None participated in combat in WWII.

INTERNATIONAL STAR

North American Aviation had what some might call "the magic touch". The NA-16 was one of NAA's first designs (second after the O-47 observation aeroplane) and like virtually all of its future designs, it was a major success both functionally and commercially. Not only were these aeroplanes and their variants highly prized by the U.S. military air forces, nations all around the globe desired them and unhesitatingly put in their orders. Between 1935 and 1939, sixteen nations bought or produced under export licences NA-16 variant model NA-47, including both Germany and Japan. 1,935 NA-16s were built but to this writer's knowledge only one original, intact, American built NA-16 survives to this day — NA-16-2A/NA-20 "FAH-21" which can be seen at the Honduras Air Museum at Toncontín, Honduras.

NA-64 YALE

The instance of the RAF obtaining "Yale" trainers (a slightly

Yes, this handsome, rugged- looking fighter is an N-16 variant. 1941 photo of a USAAC P-64 with pre/early- war U.S. markings and (unusually) in a sort- of early-war RAF camouflage (Dark Earth approximately (FS 30118) and Dark Green (FS 34092) above, but with Light Grey (FS 36440), similar to RAF Sky Grey, underneath. This aeroplane was apparently not intended for export to the RAF as it is marked with USAAc insignia. Export military aircraft were typically either painted without insignia or painted with the purchasing nation's insignia. Also, early RAF Standard Land, Day Camouflage in 1939 designated that the starboard wing underside be painted White and the port underside wing painted Black for easy "friendly aircraft" recognition from the ground. By the time of the Battle of Britain (summer 1940) RAF Standard Land, Day Camouflage designated the under-colour to be "Sky Blue" (FS35622) , a light pastel blue (duck-egg blue). An entirely different colour called "Sky Type- S" (FS 34324), a sort- of duck-egg green (that looks nothing like the sky, even over England where it is usually an about- to- rain slate grey) was sometimes painted on the underneath of the entire aeroplane. Sometimes the under-colour was Sky Blue and the fuselage band was Sky Type- S. Variations abounded.

altered BT-9) involves a bit of serendipity as the aeroplanes that the RAF eventually received, which were improved NA-64s (not to be confused with P-64), were actually supposed to go to the French Air Force, Armée de l'air in 1940. The French government finally, but as it happened far too late, came to the realisation that they required a good intermediate trainer. They received some NA-64s which they called « North » just a few weeks before the Nazis invaded and quickly overwhelmed the French Army and Armée de l'air between 10 May and 26 June, 1940. The Nazis were no doubt grateful to accept these 111 brand new and excellent American trainers for which they themselves had no equivalent aeroplane. These NA-64s were assigned to Goeppingen A/B 116 and the "Rosarius Circus" which trained German pilots assigned to fly captured Allied aircraft and some were eventually distributed for Luftwaffe Advanced training at its Flugzeugführerschulen (pilot schools). However, many of these captured NA-64s eventually went into operational Luftwaffe service as observation aircraft.

Of the batch of NA-64s which were earmarked to go to France, 120 still remained in California when France fell. Looking for another purchaser, NAA contacted the British Office of Aircraft Acquisition and inquired as to their possible interest in a Basic training aeroplane. Up to this late time the RAF had nothing like NA-64; however, they quickly realised that such an aircraft would be a fine addition to their flight training programme and they purchased the lot.

In a truth- is- stranger- than- fiction moment, to comply with the Byzantine existing neutrality laws fostered by a largely isolationist U.S. Congress, these NA-64s were flown very close to the U.S./Canadian border and were pushed across to Canada. Being in the deepest throes of The Battle of Britain in July 1940, the British Commonwealth Air Training Plan was conceived in which all RAF and RCAF flight training would henceforth take place in Canada. Accordingly, designating NA-64 as "Yale 1" after the venerable American University in New Haven, Connecticut, USA, the 120 aeroplanes were purchased and received.[8] From August 1940, these aeroplanes were incorporated into flight training at No. 1 Service Flying Training School (S. F. T. S.) at Camp Borden, Ontario, Canada, and soon after also at three other Canadian flight schools. This practice of naming imported American trainers after American Universities was followed later on when AT-6's were purchased by the British which they designated "Harvard".

Export NA-64 Yale 1s were an amalgam of the old and new, and differed from other NA-64s in that they maintained the earlier NA-16- style straight trailing edge wing plan, while the contemporary NA-64/BT-14, which was the latest and last fixed- undercarriage NA-16 variant, had a trailing edge which was slightly swept forward in a further but fruitless attempt to help improve the vicious departed flight characteristics of the earlier NA- 16 series aircraft.

As with BT-14, Yale 1's fuselage was lengthened by five feet and the fabric removable panels replaced by aluminium ones. The rudder was of the new triangular shape with its lowest part having a longer chord to prevent it being blanked- out in high Alpha conditions. Yale 1s' seats (which were set up and intended to go to Armée de l'air) were also different and were designed to fit the unique French parachute packs. Other differences include the throttle control and mixture controls which operated in reverse of American and British controls in that the throttle was pulled rearward to increase power and the mixture control was pulled rearward to enrich the mixture.


Captured NAA.57. Luftwaffe photo circa 1942.

WIRRAWAY

Not all of the NA-16s which were flown by other than U.S. air forces were built in the United States. In 1936 The Royal Australian Air Force (RAAF) sent inspectors to NAA to see what this new trainer they had heard of was all about. The upshot was that on 10 March 1937 the RAAF purchased one NA-32 and one NA-33 (essentially the same as the NA-32 but with retractable undercarriage), both which were NA-16s especially built to RAAF specifications. Also included in the purchase was a licence to build NA-32s and NA-33s as well as the excellent and reliable 600 hp Pratt & Whitney R-1340 S1H1G radial engine at the Commonwealth Aircraft Corporation (CAC) located at Port Melbourne.

Construction of these aeroplanes and engines commenced on 22 September 1938. The RAAF designated them CA-1 "Wirraway I", which I am informed is an Aborigine word meaning "Challenge". At the time they were purchased, the Wirraway series were the RAAF's only fighter/bombers and utility aircraft equipped with various armaments including, as shown here with two 0.303 in (7.62 mm) Vickers Mk. V machine guns synchronised to fire through the propeller arc, and one 0.303 in (7.62 mm) Vickers GO machine gun in a flexible Scarf mount facing rearward. Additionally, various light bomb loads could be carried under the wings.

The RAAF found multiple uses for Wirraway: forward observation, fighter/bomber,

interceptor, long range reconnaissance. Allied air activity during the New Guinea and Rabaul campaigns saw RAAF Wirraways of No. 21 and No. 24 Squadron performing useful duty.

Being derived from a design that was not at all intended to be that of a fighter aeroplane, Wirraway is nevertheless the only one of the AT-6 variants to score an air-to-air kill in any conflict. On a routine reconnaissance mission on Boxing Day, 26 December 1942 during the The Battle of Buna - Gona (16 November 1942 - 22 January 1943) which was a part of the New Guinea campaign conducted by Australian and United States sea, land and air forces against Japanese beachheads at Buna, Samananda and Gona, Pilot Officer John S. (Jack) Archer and Gunner/Radio Operator Sergeant J. L. (Les) Coulston, both from Melbourne, Vic, of RAAF No. 4 Army Cooperation Squadron were flying over the wreck of a Japanese transport off the Bona coast. The transport was suspected of being used by the Japanese to spot and report Allied aircraft movements. While patrollng the ship, Archer saw a single Mitsubishi "Zero" below him and realized that the"Zero"pilot has not yet seen him. Despite the fact that the "Zero" was well-known to be one of the deadliest Japanese fighter aircraft in the Pacific Theatre, PO Archer dove on the "Zero" from above and behind it, firing his two forward-firing Browning, .303 calibre machine guns when he was in range. Passing the "Zero" in the dive and taking advantage of his high airspeed, PO Archer continued to dive and ran for home — the "Zero" flipped inverted and dove into the sea. For this valiant action Flight Lieutenant Archer received a Silver Star from the United States.

NOTHING SUCCEEDS LIKE SUCCESS

As of the end of the 1930's, NAA was the world's premiere manufacturer of training aircraft. The immense aeronautical and commercial success of NA-16 and its progeny, while a satisfying achievement worthy of praise and a high place in the annals of aviation history in and of itself, had an even greater role to come that could not be foreseen when it began. Now, surely emboldened by its first triumphant venture, NAA made a daring decision to enter a competitive design to satisfy the USAAC circular (Number 38-385) in March 1938 in which was described their next bomber's specifications.

NAA had no prior experience with bombers or any multi-engined aircraft, yet it felt confident to design and submitted the exceptional NA-40 to the USAAC. The Army aviators immediately appreciated the brilliance of the design which became B-25 "Mitchell" bomber, after General William "Billy" Mitchell, who had received tremendous, myopic resistance when he presciently and controversially championed tactical and strategic aerial bombardment in the early 1920s (and after whom I have been told, but don't necessarily believe, I may have been named).

Displaying unusually dauntless spirit, no doubt engendered by the success of NA-16, when NAA approached the

Restored CAC-3 "Wirraway" Fighter /Bomber in early war RAAF camo of matte or semi-matte Earth Brown (approximately FS 30099) and matte or semi-matte K3/117 Foliage Green (approximately FS 34092) with matte or semi- matte Sky Blue (approximately FS 35622) underneath. The interesting insignia is actually the usual tricolour Type A RAF/RAAF roundel and fin flash but with the red centre circle and the forward red stripe of the Type A fin flash omitted. This was done in May 1942 contemporaneously with and for the same reason that the red centre circle of the USAAC-F and USN/USMC insignia was omitted — fear of it being mistaken for the Japanese Hinomaru.
The current RAAF roundel with red kangaroo facing left or forward in the centre was adopted on 2 July 1956. Prior to that the RAAF displayed RAF roundels.
Note that this aeroplane has the 600 hp P&W engine and retractable undercarriage of an
AT-6, and the round-bottom rudder and fabric fuselage covering of a BT-9.
This was typical of Wirraway which was a hybrid/"missing link" type — so very Australian.

British Air Council Sub-committee on Supply headed by Sir Henry Self to see if they were interested in the NA-40 "Mitchell" bomber, Sir Henry, duly impressed and placing a large order for same, asked NAA President "Dutch" Kindelberger if they would also produce Curtiss P-40's for them. It not being in his wheelhouse to imitate anyone else's designs, Kindelberger told Sir Henry that NAA could build an entirely new fighter that would be far superior to the Curtiss P-40 in less time than it would take to establish a production line to build P-40s. A new fighter was designed by NAA's design team headed by lead engineer Edgar Schmued, and a prototype was built ready for flight testing in only 102 days. This aeroplane was NA-73X/P-51A "Apache", the predecessor of P-51 "Mustang".

One can only speculate, but with good reason, that but for the success of the NA-16 series, NAA might never have created and provided to the Allies these aeroplanes which so greatly aided and enabled victory in WWII. In any event, had NAA not produced B-25 and P-51, it would likely still have gone down in history as one of the most significant aircraft manufacturers.

BT-9/NJ-1

BT-9 and NJ-1 were the first of the NA-16 series to be purchased and used as trainers by the by the USAAC (BT-9) and the USN/USMC (NJ-1). The first incarnation of these aeroplanes had removable fabric panels covering the fuselage and was designated NA-19.

Among those who flight tested the BT-9 prototype was no less than the great, late Paul Mantz, who was a successful air racer and Hollywood's most sought after stunt /precision pilot. His film career spanned from 1930 to his tragic death on 8 July 1965 while making the film "The Flight of the Phoenix" (1965) with aviator/actor Jimmy Stewart. Mantz was recruited to test the new aeroplane particularly because of its problematic spin recovery characteristics. While Mantz was apparently able to recover from a number of spins including a few of the flat variety, i.e., where the nose of the aeroplane remains high, at or near the horizon whist in the spin, BT-9's treacherous stall/spin remained a serious problem.

In mid- 936, 229 BT-9s were eventually purchased by the USAAF and shortly thereafter 40 by the USN/USMC which it designated NJ-1. While BT-9 was powered by a 400 hp Wright R-975-7 "Whirlwind" radial engine, NJ-1 was powered by an early version of the new 550 hp Pratt & Whitney R-1340 "Wasp" radial engine, similar to that which later powered AT-6/SNJ. It was this large purchase that convinced NAA to move from its rather small factory at Dundalk, Maryland to a far larger space available at Inglewood, California. Besides the great increase in the size of its facilities in California, the weather there was an improvement as it permitted virtually year- round flying, and there was a large local population of educated and talented potential employees.

BT-9/Yale 1/NJ-1 were the first modern, purpose-built training types and were successful as an intermediate platform for teaching the art of flying — up to a point as we shall see. The USAAC based the BT-9s at Randolph Field at San Antonio, Texas with high hopes of taking fresh and earnest Primary cadets to the next and more challenging level of airplane driving as did the RAF and RCAF at Canadian flight schools. What was soon discovered, however, was that in slow flight and departed flight regime, i.e., stalls and spins, the aeroplane was just too unstable and unpredictable to safely teach these essential maneouvers.

BT-9, etc. exhibited a sudden and violent asymmetrical wing tip stall with an accompanying fast wing drop which would often suddenly put the aeroplane on its back, which almost always immediately thereafter became a wicked and rapid spin that was very difficult even for an experienced and seasoned pilot to recover from. After BT-9, etc. instructors constantly found themselves in what they might have called "A high pucker factor" while demonstrating spins and

Pilot Officer (PO) John S. (Jack) Archer and Sergeant J. L. (Les) Coulston, both from Melbourne, Vic, seated in RAAF No. 4 Squadron Wirraway A20-103

Paul Mantz's last flight in the aeroplane that was built for the 1965 film "Flight of the Phoenix". Underpowered and over- stressed, it hit a sand dune and broke up, killing Mantz.
Bobby Rose, a stuntman standing behind Mantz in the cockpit was seriously injured.

recoveries, this part of the curriculum was temporarily abandoned until it could be sorted out what was wrong with the aeroplane and what could be done to correct it.

The first attempt to tame BT-9, etc.'s stall and spin was the installation of aerodynamically movable slats in the outer wing panels (similar to those found on Messerschmitt BF-109). This was a valiant try, but it was to no avail as the problem was actually deeper in the actual wing design than was at first suspected. Engineers at Randolph Field, where most of the BT-9s were based, tried installing a series of stall strips on the leading edge of the wing to attempt to equalize the air flow across both wings at high angles of attack (Alpha) to prevent the sudden wing drop at the stall. This was a successful method for taming the Chance -Vought F4U "Corsair" which also suffered from a serious asymmetrical stall, temporarily prohibiting it from aircraft carrier operations for which it had been designed in the first place. While stall strips worked for "Corsair" and were slightly more effective than the movable slats had been, they did not cure the stall/spin problem for BT-9.

Wright Field engineers who studied the problem suspected that BT-9's rudder was being blanked out by the wing when the aeroplane was in a deep stall or spin attitude. NAA engineers took a good look at the wing design and decided that what was actually needed was 2° washout, i.e., the outer section of the wings are "twisted" so that the trailing edge is raised higher than the leading edge at the outer wing area. This reduces the Alpha at the outer wing relative to the inner wing area which is unchanged and will stall first. Also, BT-9's fuselage was lengthened by 5 inches to increase the moment arm of the rudder and thereby its effectiveness, and also to hopefully move it to a place where it would not be blanked- out by the wing at high Alpha. This improved variant was designated BT-9A.

It was all of no avail; the latest BT-9A still remained unstable in departed flight. This was a frustratingly severe handicap for what was supposed to be, after all, a Basic trainer, an aeroplane in which aerobatics and departed flight were to be taught and practiced. Of course, the USN/USMC found the same problems with their NJ-1's which, except for their larger engines, were essentially identical to BT-9. The Navy restricted NJ-1 from intentional stalls/spins and also, for some reason, from night flying, further limiting NJ-1's practical use as a Basic trainer.

The RCAF simultaneously discovered the departed flight instability in their Yale 1s. The upshot was that they soon relegated Yale 1 to radioman training duty in which extreme manoeuvring was not part of the curriculum. To this day many pilots of those BT-9s and Yales that still are flyable report that they are far more tricky and demanding to fly than AT-6's /Harvards.

During the time that the BT-9/Yale 1/NJ-1 was in service, a single Browning M-2 .30 calibre machine gun was occasionally installed in the upper right cowling just ahead of the cockpit, firing through the propeller arc using an upgraded WW I- style interrupter system, as well as a rearward facing, single Browning M-2 .30 calibre machine gun on a flexible Scarf mount which could be manned from the rear cockpit.

Alternatively, some export variants had additional guns installed with as many as five of these guns in the nose and wings. In BT-9, etc. these guns were used for target practice. Also, a Type T-3A aerial camera was commonly installed in the left wing and operated by depressing the firing button on the top of the control stick for mock dogfight review.

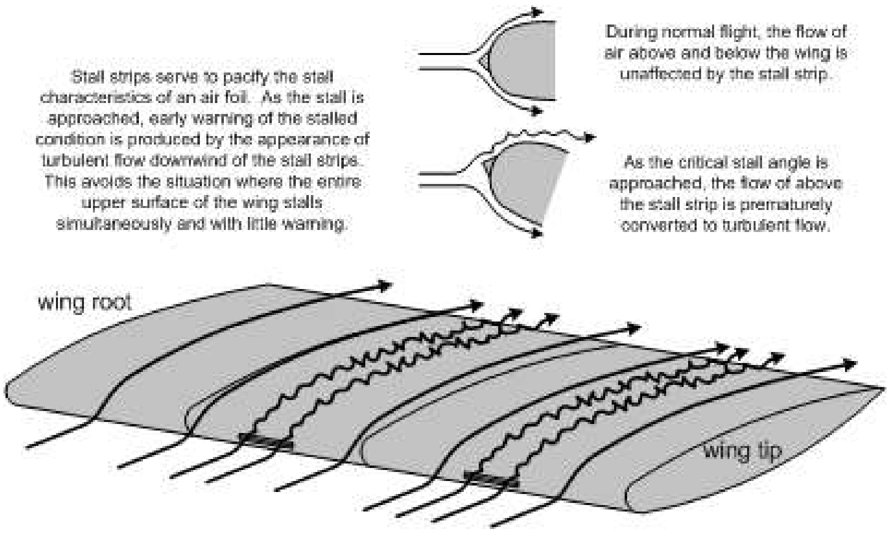
NA-28/NJ-1

Ordered in December 1936, this was the first aeroplane that NAA had built specifically for the USN/USMC. Its airframe was virtually identical to that of the USAAC's BT-9, but it was, as mentioned, powered with a 550 hp Pratt & Whitney R-1340 "Wasp" engine. The USN/USMC considered NJ-1 to be an Advanced trainer, which made sense as the USN/USMC's first- line aircraft in 1936 were the Grumman FF-1 attack fighter/bomber and the Grumman F2F-2 fighter, both of which were biplanes.

Grumman FF-1 called "Fifi" was one of the U.S. Navy's first- line attack fighter/bombers in 1936 when it ordered 40 NJ-1 Advanced trainers from North American Aviation. Fifi was the USN/USMC's first aircraft with retractable undercarriage, enclosed cockpit and an all metal fuselage.

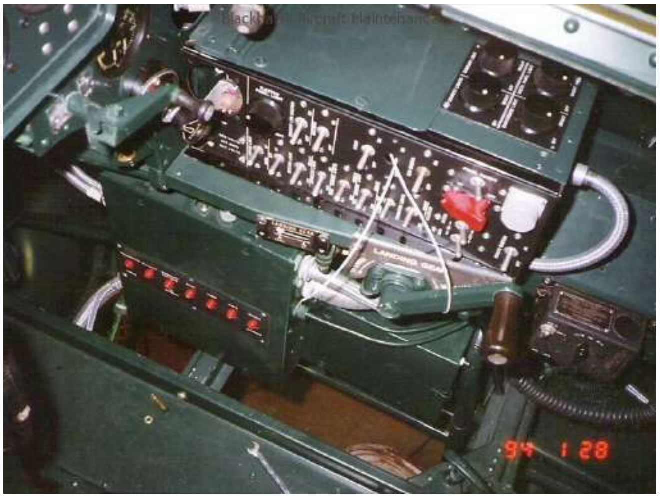
At this time Grumman's retract mechanism was solely manual and required 30 turns of a prominent crank on the lower right-hand side of the cockpit for the undercarriage to fully retract or extend. This was the system that Grumman designed and installed in all of their retractable- undercarriage aircraft up until and including Grumman F4F "Wildcat".

F6F "Hellcat", introduced in 1943, had Grumman's first hydraulic undercarriage retract/extend system.


Stall strips serve to pacify the stall characteristics of an air foil. As the stall is approached, early warning of the stalled condition is produced by the appearance of turbulent flow downwind of the stall strips. This avoids the situation where the entire upper surface of the wing stalls simultaneously and with little warning.

During normal flight, the flow of air above and below the wing is unaffected by the stall strip.

As the critical stall angle is approached, the flow of above the stall strip is prematurely converted to turbulent flow.



Interior of Grumman F4F-2 “Wildcat”. Note the prominent, safety- wired undercarriage retract/extend crank marked “Landing Gear”on the lower starboard side.
It was said that you could always recognise a pilot who flew a Grumman from the enlarged muscles of his right arm.

Flight of Grumman F2F-1s in very close formation based on the USS Lexington aircraft carrier - photo circa 1936. These were the USN/USMC’s very best first-line fighters in 1936 when far more advanced monoplanes such as the USAAC’s Seversky P-35, Curtiss P-36, British Supermarine Spitfire, Hawker Hurricane, and Luftwaffe’s Messerschmitt Bf-109 were already in being and had entered, or would shortly enter, operational service.

NJ-1, photo circa 1937. While this black and white photo displays this aircraft’s physical characteristics well, it is a shame that it is not in colour as U.S. Naval aircraft of this period were quite resplendent. The fuselage and underside of the wings were painted a gloss light grey or silver, the wing tops gloss Orange Yellow (FS 13558), the tail surfaces were painted according where the aircraft was based, here looking to be red. The cowling’s colour was painted according to flight position assignment, the solid white cowling and corresponding white fuselage band indicating the flight leader of a three-aircraft formation .

As mentioned, in 1936 NJ-1 was designated to be the USN/USMC's Advanced trainer, i. e., the last aeroplane that Naval/Marine Corps Cadets would fly before operational squadron assignment. Accordingly, while NJ-1 had a fixed undercarriage, in order that Naval/Marine Corps cadets might become accustomed to operating the retractable undercarriage of its first-line aircraft, NJ-1 was equipped with a dummy undercarriage crank (30 turns to retract or extend) and dummy undercarriage position lights which were set to operate as if the aeroplane's undercarriage was actually retracted and extended. Instructors would look into the cockpit after a Cadet landed to see if the position lights were not lit, indicating that he had failed to extend the undercarriage. To this writer's knowledge, this is the only known example of such a curious training device. Additionally, NJ-1 had no arrester hook for aircraft carrier landing training nor was it equipped for gunnery or bombing training. A similar dummy undercarriage retract/extend system is said to have been installed in some USAAC BT-14s, although with regard to such this writer cannot find any solid proof.

NJ-1 having the same wing as BT-9 suffered the same markedly unstable departed flight characteristics and was similarly restricted with regard to stall/spin exercises; not a good thing in what was supposed to be an Advanced trainer.

GETTING THERE SLOWLY – NA-26 AND NA-58/BT-14

In March 1937, a relatively obscure NA-16 variant, a most prescient single experimental

NA-26, initially designated BT-9C, was entered into the USAAC's competition for a Basic Combat aircraft at Wright Field. This aeroplane was essentially a BT-9B with a few very significant improvements and features which closely presaged the AT-6. Not the least of these was a fully-retractable main undercarriage (virtually identical to that of the future AT-6 series) and a 550/600 hp Pratt & Whitney R-1340-S1H1-G "Wasp" engine (similar to that which was installed in NJ-1) which would later also power the AT-6 series. Additionaly, as would be found on the AT-6, NA-26's rudder was redesigned to a roughly triangular shape, with the broadest part below to help to offset aerodynamic blanking of the rudder at high Alpha.

While designing the NA-26, NAA entered into a contract with the Edward G. Budd Manufacturing Co. who was thereby subcontracted to determine the structural feasibility of replacing the wings' fabric- covered panels with stainless steel panels. A new wing was also designed, slightly larger by one foot of span and seven square feet of area and had new, squared-off wing tips which would appear on all future AT-6s. The fuselage, however, still retaining NA-16's fabric side panels was the first of the NA-16 progeny to mount one Browning M-2 .30 calibre machine gun in the upper cowling ahead of the front cockpit, firing through the propeller arc with an interrupter gear as well as a rearward facing, single Browning M-2 .30 calibre machine gun on a flexible Scarf mount (as would later be installed in the Australian CAC -1 "Wirraway"). The USAAC designated this aeroplane as "Basic Combat Trainer- Type 1" or BC-1, the production NAA factory name being NA-36. Four hundred of these went to the RAF who designated them "Harvard I", and 16 went to the USN/USMC as "SNJ-1", but with a Pratt & Whitney R-1340-6 and "SNJ-2" with a Pratt & Whitney R1340-56.

In this writer's opinion these features mark the NA-26 as the unsung, but first AT-6.

The NA-26 design was accepted as best in the Army's competition and was eventually produced as the NA-36/BC-1. (No, it isn't you, NAA's production numbers often seem to make little sense and can be confusing to even the most diligent aviation historian.)

NA-36/BC-1 – ALMOST THERE

On 9 June 1937 the USAAC received its first BC-1s. Shortly thereafter the USN/USMC received their first SNJ-1s and 2s. Each one cost $17,743.40 which had the same buying power as $297,597.37 in 2015, annual inflation over this period being 3.68%.

BC-1 is a true hybrid, a sort of BT-9 and NA-26 combined. It retained the removable fabric panels on the fuselage but had the new triangle-shaped rudder of the NA-26. Its wings were of the new all-metal, single- spar monocoque (stressed skin) type, but retained BT-9's rounded wing tips. The outer wing panels had the 2º washout of the improved

BT-9A, but with increased dihedral in the outer wing panels and the swept forward trailing edge of the soon to come BT-14. Most significantly, though, it had the retractable undercarriage of the NA-26.

Curiously, although designated as a Basic Combat Trainer, BC-1 had no provision for armament of any kind. BC-1's engine was the 550/600 hp Pratt & Whitney R-1340-S1H1-G "Wasp". Except for its fabric fuselage panels it very closely resembles the coming AT-6.

NA-52/SNJ-1 was the USN/USMC variant of BC-1 and was similar to it; however, its wing had squared-off tips.

NA-54/BC-2 was designated to the last three BC-1s to be built in late 1939. These were powered with a geared 600 hp Pratt and Whitney R-1340-45 and had three-bladed propellers. They were supposed to be NAA's entry in a USAAC competition with Consolidated Vultee BC-3, the last of the Consolidated Vultee BC line; but instead were assigned to the U.S. Air Mission in Latin America, ostensibly to impress South American governments with U.S. "Air Power". In any event, it was NAA's BT-14 which became the USAAC's first choice for a Basic Trainer.

NA-55/BC-1A was far more than just an armed BC-1 as it had a metal fuselage, the new and now standard wing and tail assemblies and a geared 600hp engine. It mounted one Browning .30 calibre machine gun in the upper cowling ahead of the front cockpit firing through the propeller arc with an interrupter gear as well as a flexible mount for another single Browning M-2 .30 calibre machine gun on a flexible Scarf mount, facing rearward from the rear seat as with NA-26. Mostly sent to Air Corps Reserve and National Guard units, a few also served in USAAC squadrons. Except for a large Direction Finding (D/F) loop mounted under the fuselage between the wheel wells, BC-1A appears identical to the soon to come AT-6.

BC-1A. Photo circa 1941. This is a USAAC aeroplane based at Oakland, California with a trainer unit number. The fuselage is natural metal with a clear top coat and the top and bottom of the wings are Orange Yellow. The rudder bears the single Insignia Blue vertical and thirteen Insignia Red and Insignia white alternating horizontal stripes which appeared from time-to-time on the rudders of various USAAC+ and USN/USMC aircraft from 1926 - 42.
Note the retractable undercarriage, triangular rudder and metal panels on the fuselage. This aeroplane is just a hair's width from AT-6 and is visually distinguishable from it only by the large D/F loop under the forward fuselage (or is it ? - see below).

A NEW IDEA

Once BT-1 and BC-1A were in operational service and performing well, USAAC senior officers saw that a new breed of training aircraft was now available and began to lay out the genesis of an Advanced Training Curriculum which they hoped would enable cadets to be trained even closer to operating first-line fighter aircraft than had previously been possible. The additional weight of the retract mechanism and the larger and heavier P & W R-1340 engine added to the overall heft of the BC-1/BC-1A which was considered a positive training advance as cadets would now have experience flying an aeroplane closer in weight to current first-line fighters. [BC-1 max. takeoff - 6,730 lbs (3053 kg); P-40B max. takeoff - 7,610 lbs (3451.8 kg)]

In late 1939, and within a few months after BC-1's entry in service, NAA would present its highest achievement in training aircraft, AT-6. The USAAC's nascent Advanced Training curriculum now had its ideal partner, an aeroplane which would soon enable military flight training in the United States to make a great leap forward.

After the entry of AT-6, all BC-1/BC-1As were eventually transferred to the USAAC's training facility at Kelly Field at San Antonio, Texas and became instrument trainers designated BC-1-I until 1942 when the type was withdrawn from service.

NA-58/BT-14

While the first Advanced trainer was about to be born in 1940 with much celebration and positive antici...pation, the USAAC still required a good Basic trainer to replace the BT-9 which had been in hard service since 1936. NAA was, as always, equal to the task and on 9 September 1939 the first NA-58 was delivered to Wright Field for evaluation and approval for operational duty. Designated BT-14 by the USAAC, it was the last fixed- undercarriage variant of the prolific NA-16 series and was intended to be the latest and last of NAA's Basic trainers. Given all of the reported problems of the BT-9/NJ-1/Yale 1 series a major airframe improvement an alteration was surely overdue and it came with his model.

BT-14's fuselage was now completely covered with removable metal panels and was stretched five feet longer to increase the tail section's moment arm and thus increase control efficiency. It was wider from the cowling rearward and the cowling's front opening was now made smaller to reduce drag. A re-designed canopy now was in place, and the upper fuselage ahead of the windshield was re-designed to curve more sharply downward for better visibility.

While BT-9, etc. was powered by a 400 hp Wright R-975 engine, the BT-14 was powered by a 450 hp Pratt & Whitney R-985 "Wasp Junior" mounted a few inches further forward to maintain the CG which had been altered by the aft fuselage stretch. It was the only NA-16 variant to use this engine. Gone was the corrugated metal skin of the vertical fin and stabilizer. In its place were smooth stressed- skin metal panels. BT-14 also had the new triangular- shaped rudder.

However, the greatest change in BT-14 was in the wing. The trailing edge which had formerly been straight on all prior NA-16 variants was now slightly swept forward in one more attempt to cure the NA-16 series' vicious stall/ spin behaviour. As with all of the other exterior "fixes", it failed to solve the problem.

NA-59 -AT-6/HARVARD II

Taking what was by late 1939 a very familiar design and giving it a close look to see what, if anything might be improved, "Dutch" Kindelberger and Lee Atwood began with a clean drawing board, ready to keep what had proven to be good and useful and to eliminate and re-design that which had not proved to be so.

DAYTON, Ohio — Diorama featuring an actual BT- 14 appearing in the Early Years Gallery at the National Museum of the United States Air Force. This somewhat humorous but instructive exhibit demonstrates what was a too- common flight- training incident resulting from taxiing with the wind from behind, elevators up (stick back) while applying brakes with too much vigour. In such a circumstance the wind gets under the upraised elevators and tends to lift the tail and harshly applied brakes finish the job — down goes the nose and the turning propeller strikes the ground resulting in propeller, engine and airframe damage, not to mention extreme embarrassment (as well as disciplinary action and perhaps washout) for the hapless pilot. On average during WWII, approximately 40 percent of cadet pilots did not graduate from flying school, largely from careless aircraft handling such as this.

Same diorama from a different angle. BT-14's distinctive triangle fin/rudder and fixed undercarriage can be seen. The aircraft's colours are seen truer here as the lighting is better. The fuselage appears to be is painted "Light Blue 23", and the wings and tail surfaces "Chrome Yellow".

Some of this improvement had already been done with the very last few BC-1As which were re- designated as Advanced Trainers. The greatest advancement was that the wing was completely re-designed with new airfoil ordinates. After many years of trying external fixes to make the original NA-16 wing stall and spin less viciously and with some predictability, the NAA design team finally came to what the problem had been all along — they had made a crucial mistake with regard to the original NA-16's airfoil ordinates. As mentioned, they had taken the airfoil from DC-2's excellently performing wing (for DC-2 that is) and transferred it to NA-16s much smaller wing. However, they had overlooked something — Aerodynamic Scale Effect.

Aerodynamic Scale Effect (ASE) is an observable phenomenon which when taken into account permits the comparable measurement of the predictable performance of identical airfoils of different dimensions. The wing's Reynolds Number[9](RN) is most crucial in this study.

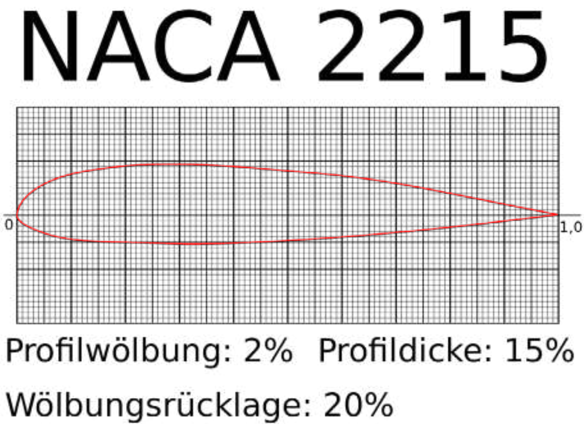
The basic idea is that while two or more wings may be of varying size, even if of proportionally exact dimensions, the molecules of the air in which they fly do not change to accommodate the change in the size of the wing, they remain the same. Accordingly, the way that lift and drag are produced by the movement of each wing through air molecules and the resulting performance of each wing will vary in proportion to the size of the wing. Smaller exact- scale versions of larger wings do not perform the same or usually as well as their larger counterpart. Also, variations in airspeed cause varying performance, as airspeed is a prime component of the RN.

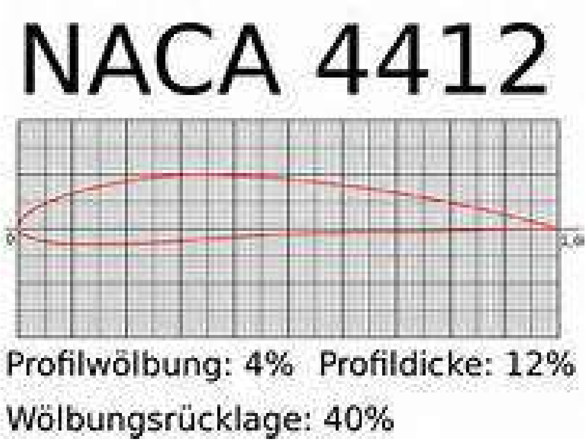
When DC-2's wing dimensions were diminished for use in the much smaller NA-16, the resulting differences in performance caused by ASE were apparently not taken into consideration. With reference to RN, reasonably assuming that the airfoils which are being measured (DC-2's and NA-16's) are flying in the same basic atmosphere and at the same airspeed, the only variable then remaining is the difference in the chords of their wings, and in that there is a very large difference: DC-2's mean (average) chord is 11.05 ft. while NA-16's mean chord is 5.75 ft., slightly more than ½ of that of DC-2's.

Both DC-2 and NA-16 variants fly within similar airspeed envelopes (DC-2 cruise at sea level - 157 mph, NA-16 cruise at sea level - 146 mph) in the same atmosphere. As we have seen, the remaining factor, each wing's chord, differs by a great deal. Accordingly, the RN for DC-2 is nearly twice that for NA-16 when flying at the same airspeed and altitude.

With this in mind it is no wonder that NA-16's wing, having the same airfoil ordinates as that of DC-2 but with roughly 1/2 of DC-2's RN, suffered a number of performance deficits, including and specifically poor departed flight characteristics. Radio Control (R/C) aeroplane modellers know that if they incorporate a full- sized aeroplane's airfoil on a much smaller (usually ¼ size or less) scale flying model of that airplane that they will likely have serious flight issues, mostly in the slow flight and stall regimes.

Once the real problem with NA-16's wing was understood by NAA's engineers the solution was a simple matter of changing the airfoil to suit the lower RN of the smaller wing. In March 1940, a new wing was designed with new airfoil ordinates being NACA 2215 at the root (which is, coincidentally, Curtiss P-40's wing root airfoil) and NACA 4412 at the tip.





- Profilwölbung – profile curvature
- Profiledicke – profile thickness
- Wölbungsrücklage – Greatest point of thickness measured in percentage from the leading edge.

These new airfoils were known to provide excellent performance at the lower RN of the soon to be AT-6, and the last few BC-1As received these new wings along with an enlarged centre section to accommodate the wheel wells as well as two separate fuel cells containing a total of 170 U.S. gallons.

Once these new wings were installed on BC-1A airframes and the aeroplanes test flown, for the first time in the entire NA-16 series, stalls and spins were found to be predictable, manageable, and reasonably docile. The formerly built-in 2° washout was removed and dihedral was reduced from 7° 6' to 5° 11' in each outer panel to improve roll rate.

As it is with many things, the solution to the problem was just waiting to be discovered by going back to basics and honestly evaluating what was there and what required a new approach. Now came the aeroplane that all of the NA-16 series had been heading for — NA-59/AT-6/Harvard II.

Considered by many to be a purely wartime U.S. aeroplane, NA-59/AT-6/Harvard II was actually contracted for by the USAAC on 28 April 1939, some 4 months and 2 days prior to what is considered to be the date of the start of World War Two — September 1, 1939, when the Nazis invaded Poland, and 2 years, 7 months and 9 days before the United States entered that war.

Kindelberger, Atwood and their superb design team had been working hard to finish the final touches of what they all believed was NAA's ultimate achievement in a military Advanced trainer. They had never let the concept of military training, i.e., to prepare cadets to fly first-line fighters and fighter/bombers, slip far from their thoughts. Here at last, with the stubborn departed flight problems of NA-16 behind them, a new breed of training aeroplane, the first modern, purpose-built Advanced trainer was ready to take its place in aviation history.

Taking the lessons learned and the best design features of each NA-16 variant and further refining them, NA- 59-AT-6/Harvard II was born. The first 96 of these aeroplanes delivered to the USAAC were initially, and sensibly designated "AT-1" as it was, indeed, the first USAAC Advanced trainer to come into being. The Advanced Flight Training course itself was not yet completely formulated or instituted and all of this was new, uncharted, but exciting territory.

HOW THE USAAC'S FIRST ADVANCED TRAINER BECAME AT-6

On 1 December 1939, the USAAC assigned the first ninety-four NA-59/AT-1s to fourteen different bases in the continental United States for evaluation and demonstration purposes, the largest number of which, fifty-two, went to Kelley Field, Texas to commence the new Advanced Training curriculum.

Six of these were soon transferred to the USAAC Hawaiian Department in Honolulu, Hawaii, two of which went to the USAAC Hawaiian Air Force (7th AF) at Wheeler Airfield and survived the Japanese surprise attack on 7 December 1941. All of these aeroplanes reached their various destinations by March 1940 as AT-1s[10] and are the first of this type to go into active USAAC service.

At some point in late March 1940, someone reminded the USAAC that the designations "AT-1" though "AT-5" had already been issued in the 1920s. After some embarrassed clearing of throats, the USAAC re-designated NA-59 as AT-6.

JUST A CAUTIONARY WORD FOR AVIATION HISTORIANS

As mentioned, BC-1A was essentially an AT-6 in every possible way except for a large D/F loop installed under the front fuselage between the wheel wells. However, in May 1943, the USAAF authorized the Air Force Instructor (Instrument) School at Bryan, Texas to install similar D/F loops on their 170 various AT-6 variants exactly where BC-1A's D/F/ loop had been. Accordingly, aircraft recognition "experts" and historians should take care.

Life Magazine 1943 Photo of a Women's Air Force Service Pilot (WASP) boarding an BT-13.

SNJ-2

This was USN/USMC's version of AT-6 except that, like BC-1, it had no provision for armament at all which seems curious for a Scout Trainer. SNJ-2 had a slightly larger wing than AT-6 and was powered by a Pratt & Whitney R-1340-36. Additionally, SNJ-2 had a leather headrest and a provision for a chart-board for the forward pilot.

As an aside, The Skytypers, a skywriting and airshow exhibition company in operation since 1946, incorporates a unique system of "Dot Matrix Skywriting" whereby six aircraft in information at 10,000', through an integrated -computer system, emit puffs of white smoke at short intervals spelling out words. The Skytypers have always flown 1940's era SNJ-2s and were based for decades at the former Flushing Airport (Speed's Airport), Flushing, Queens, New York City until it was closed in 1984 after public outcry following a fatal accident involving a Piper Twin Comanche which crashed too close to a nearby apartment building. The Skytypers are now based at Republic Airport (FRG), Farmingdale, New York.

NA-66/HARVARD II

By November 1939, with the new war only a month old, the British Purchasing Commission placed an order with NAA for an astounding 600 AT-6s, which they called Harvard II, 513 to be delivered to RAF and RCAF flight schools in Canada. Shortly after it had been instituted in the U.S., the RAF, and RCAF agreed that the U.S. concept of Advanced training before Transitional or OTU assignment was not only a good idea, but crucial to insure a steady flow of competent and experienced pilots, and it was added to the Commonwealth Air Training Scheme.

As mentioned, all RAF and RCAF flight training was to be conducted in Canada to avoid injury to the cadets, damage to the precious Advanced training aircraft and to avoid interruption of training by Nazi air attacks in Britain. While NAA had no problem with this order, nor did President Roosevelt and his administration, the Neutrality Act of 1939, the latest of many Neutrality Acts passed by the U.S. Congress in the 1930s to keep the U.S. out of a European war, prevented NAA from flying these Harvard IIs into Canada. Innovation never being in short supply at NAA or in the RCAF, in the summer of 1940 as the Battle of Britain raged full in the blood- shot skies of Britain, it was arranged that Harvard IIs and other aircraft purchased by the Commonwealth would be flown to an airfield at Pembina, North Dakota very near the Canadian border at West Lynne, Ontario and pushed across, whereafter they would be flown to various RAF and RCAF training bases throughout Canada.

Appropriately, RCAF's first Harvard Mk. IIs went to the historic birthplace of the RCAF, Camp Borden, north-west of Toronto, Ontario in the summer of 1940.

In September 1940, with a good deal of arm-twisting, and with the sincere compassion and good-fellowship ("mateship" for you Aussies) of many in the U.S. Congress, engendered by stunning reports of the Battle of Britain and the horrific bombing of British cities, President Roosevelt managed to have the embargo of aircraft to Canada lifted in September 1940. The Lend- Lease Act of March 1941 finally put an end to unreasonable "neutrality" nonsense. All U.S. aircraft purchased or "lent" to Great Britain and the Commonwealth were thereafter flown directly into Canada.

Harvard II was essentially similar to AT-6 and AT-6A except that it had an elongated non-opening rear canopy section, a longer exhaust stack incorporating a cockpit heater — a necessity for flying in the brisk Canadian skies at least nine months of the year, British-style instruments similar to those found in Spitfires and Hurricanes, a British-style control column with hand operated brake controls, provision for a .303 calibre machine gun and ammunition to be mounted in the starboard wing with a camera to record practice dogfight results in the port wing, a gunsight in the windshield, and hard-points with release mechanism under the wings for up to 4 practice bombs under each wing. Also, every RAF and RCAF Harvard II and every subsequent Harvard variant had the undercarriage strut doors removed, probably because of problems with the doors catching snow when taxiing.

Restored Harvard II showing full-flaps for landing.

Restored Harvard II showing dull- coloured Type- A roundel on the fuselage and Type-B roundels on the wing tops. Type- A1 roundels had an additional yellow outer band equal to the blue and white band. Type C roundel had a thin white middle band and no yellow band. Type C1 was the same as Type C but with a yellow outer band. Type D roundel, applied from 1947 and thereafter has a larger red centre circle equal to the white and blue bands.
RAF fin flashes always show the red stripe to the front, French fin flashes are reversed. This fin flash is Type A — three equal stripes. Type B fin flash is red and blue with no white stripe, and Type C fin flash has a thin central white stripe.

Of those few Harvard IIs that were shipped to England, most of them, as well as all of the Harvard Is already in England, were soon dispatched to Southern Rhodesia for training purposes, and two were "given back" to the USAAF's 8th Air Force based in Great Britain.

British orders for Harvard IIs to be assigned to various Commonwealth countries and territories world-wide were made and these aeroplanes were called Harvard Mark II but were identical to Harvard II. The RAF and RCAF finding this aeroplane more than satisfactory, further orders for Harvard II were made by the British Purchasing Commission. By the end of the summer of 1940, the 1000th Harvard II was delivered to the RAF/RCAF.

NA-77/AT-6A-NA/SNJ-3/ SNJ-3C- THE DEFINITIVE AT-6

As of the USAAC's order of 28 June 1940, with few significant exceptions, the final dimensions, etc. of the entire NA-16 series was fixed with AT-6A/SNJ-3. The instrumentation and controls in the rear (instructor's) cockpit position had always been more spartan than those of the front cockpit position, but in the AT-6A, etc. the rear cockpit was better equipped than in previous variants although not yet equal to the front cockpit.

For the first time the USAAC and USN/USMC versions of this aeroplane were identical and would remain so thereafter. In fact, the only difference between them is the designation numbers of their engines, R-1340-49 for the Army, and R-1340-38 for the Navy, the Navy having its own slightly different requirements. The USN/USMC accepted the triangular rudder for the first time leaving the old, round, flat bottom rudder that it had favoured to history.

In this latest incarnation of NA-16 the rear of the canopy could be swung forward to provide a windscreen when the rear gun was manned. It had the same machine gun mounts as a BC-1A/AT-6 except that the rear seat now could swivel 360º for easier use of the gun.

Some SNJ-3s were fitted with arrester hooks in the tail for aircraft carrier training and designated "SNJ-3C". Of course, the rearmost fuselage structure was appropriately beefed up in the "C" models to take the sudden jerk of catching that third wire. The added "C" designator carried over to all future carrier- ready SNJ's.

While it was considered that the NA-16's vicious stall/spin problem had been corrected, there were a few reports of the AT-6A requiring as many as four turns to recover from a spin. Accordingly, on all further AT-6A/SNJ-3s the stabilizer was triple reinforced, however, the vast majority of AT-6 pilots have not reported that spin recovery is a problem.

As the first purpose-built Advanced trainer, AT-6/SNJ/Harvard served the USAAC-F, USN/USMC, RAF, and RCAF very well, indeed. Cadets graduating from these trainers found, as it was intended, that transition to powerful first-line fighters was natural.

However, the poor forward view of most fighters, caused by long engine cowls (as with P-40 and P-51) or rearward cockpit positions (as with F4U "Corsair") remained a problem. To accustom Cadets to this, a few flights from the rear seat where the forward view was as bad or worse was added to the Advanced flight training curriculum.

During WWII, a total of 1,847 AT-6As were built, 517 at the Inglewood,California NAA plant and 1,330 at the Dallas plant where all NAA production was transferred. Of the Dallas built AT-6s, an additional 399 were AT-6-B gunnery-trainers, 2,970 AT-6Cs, 3,404 AT-6Ds and 956 AT-6Fs.

AT-6 WWII VARIANTS

AT-6 TEXAN: Advanced Trainer - same as BC-1A with minor changes, powered by a 600hp R-1340-47 and armed with forward-firing .30 calibre machine gun, nine original started as BC-1As and 85 built.

AT-6A: Same as AT-6 but with 600hp R-1340-49 and removable wing centre section fuel tanks, 1,847 built with 298 transferred to the United States Navy as the SNJ-3. Survivors re-designated T-6A in 1948.

AT-6B: Same as AT-6A but with 600hp R-1340-AN-1 and dorsal gun fitted as standard, 400 built.

AT-6C: Same as AT-6B but with material changes to low-alloy steel and plywood, 2,970 built including transfers to the United Kingdom as Harvard III.

AT-6D: Same as AT-6B but with a 24V DC electrical system, 4,388 built including transfers to the United States Navy as the SNJ-5 and to the United Kingdom as the Harvard IIA. Redesignated T-6D in 1948.

XAT-6E: One AT-6D re-engined with a 575hp V-770-9 V-12 inline engine for trials.

AT-6F: Same as AT-6D but with a strengthened airframe and minor modifications, 956 built including transfers to the United States Navy as the SNJ-6, Redesignated T-6F in 1948. Clear, fixed rear canopy. Some went to Russia via Lend- Lease.

AT-16: Canadian company Noorduyn- built Lend- Lease Harvards, 1,800 built.

A-27: Two-seat attack version of AT-6 with a 785hp R-1820-75 engine and five .30 calibre machine guns (two in nose, one on each wing and one dorsal). Designation used for ten aircraft sent to Thailand and later impressed into the USAAC-F.

Of the AT-6 variants, AT-6C was unique as it had major surgery in its rear end. To reduce approximately 1,246 lbs (565 kg) and because of a perceived coming shortage of light alloy, plywood replaced the metal covering of the fin and stabilizer as well as in the structure of the rear fuselage. Also, pure aluminium was used to replace heavier alloy used in parts of the airframe.

T-6 POST-WAR VARIANTS

T-6A: AT-6As re-designated in 1948 by USAF.

T-6C: AT-6Cs re-designated in 1948 by USAF including 68 re-builds with new serial numbers.

T-6D: AT-6D re-designated in 1948 by USAF including 35 re-builds with new serial numbers.

T-6F: AT-6F re-designated in 1948 by USAF.

T-6G: Earlier model AT-6/T-6s re-built between 1949-1953 with improved cockpit layout, increased fuel capacity, P-51- style steerable tail wheel, updated radios and a 600hp R-1340-AN-1 engine. Identifiable by simplified canopy framing. 2,068 modified.

LT-6G: T-6Gs converted for battlefield surveillance and forward air controller duties, 97 modified. Nicknamed Mosquito.

T-6H: T-6Fs converted T-6G specifications.

T-6J: Designation claimed to have been used for Canadian-built Harvard Mk. 4s, however no proof has ever surfaced that this designation was ever used. Aircraft record cards and markings on aircraft called them “Harvard 4”. Supplied to Belgian, France, Italy, Portugal and West Germany. In all, 285 aircraft.

KN-1: A single T-6F damaged in a crash during the Korean War that was rebuilt as a floatplane by the Navy of the Republic of Korea.

NJ/SNJ TEXAN VARIANTS

NJ-1: United States Navy specification advanced trainer powered with 550 hp Pratt & Whitney R-1340-6. Some re-engined with later versions of R-1340. Similar to BT-9, 40 built.

SNJ-1: Similar to Harvard I but with BC-1 wing center section, metal-covered fuselage and late T-6 type wing - 16 built.

SNJ-2: Same as SNJ-1 but with a R-1340-56 engine and changes to carburettor and oil cooler scoops - 61 built.

SNJ-3: Same as AT-6A, 270 built and 296 transferred from USAAC.

SNJ-3C: SNJ-3 converted as deck landing trainers with tail hook arrester gear - 12 so modified.

SNJ-4: Same as AT-6C - 1,240 built.

SNJ-4C: SNJ-4s converted as carrier- deck landing trainers with tail hook arrester gear.

SNJ-5: AT-6Ds transferred from the USAAC - 1,573 aircraft.

SNJ-5C: SNJ-5s converted as carrier- deck landing trainers with tail hook arrester gear.

SNJ-6: AT-6Fs transferred from the USAAF - 411 aircraft.

SNJ-7: Early models modified to T-6G standards in 1952.

SNJ-7B: Armed variant of the SNJ-7.

SNJ-8: Order for 240 cancelled, none built.

HARVARD VARIANTS

HARVARD I: Similar to BC-1 but without rear gun and with a 600hp R-1340-S3H1 engine, 400 aircraft.

HARVARD II: Similar to BC-1A, 526 built, again without provision for rear gunner.

HARVARD IIA (RAF & COMMONWEALTH): AT-6C, many with wooden rear fuselages when first delivered.

HARVARD IIA (RCAF): Armed Harvard II - Any RCAF Harvard II or IIB fitted with wing guns, rockets or bombs.

HARVARD IIB: Noorduyn- built Mk. II's, some to U.S. orders as AT-16's for Lend- Lease. Transfers back from the USAAF (1,800) and 757 built.

HARVARD T.T. IIB: Target Tug - 42 aircraft built for the RAF by Noorduyn. Number probably included in Harvard II totals.

HARVARD IIF: Bombing/gunnery trainer - One-off modified from Mk. II with bomb aimer's blister and AT-6 type cockpit.

HARVARD III: AT-6D, 537 aircraft for RAF.

HARVARD 4: Canadian development of Harvard II paralleling the T-6G, and built by Canadian Car & Foundry, 270 for the RCAF and 285 for USAF.

HARVARD 4K: Belgian designation for Harvard IIs and IIIs upgraded to roughly Harvard 4 specifications.

HARVARD 4KA: Belgian designation for armed variant of 4K.

SNJ-3Cs practicing aircraft carrier operations. One SNJ-3C is still in the landing area as the following SNJ-3C is "waved off" to go around and re-approach.
During WWII, converted paddle- wheel steamers USS Wolverine and USS Sable operated as USN training carriers on Lake Michigan, as did escort carrier AVG-1, ACV-1, CVE-1 Long Island (named for Long Island, New York and which ship did such good and valiant service at Guadalcanal) off San Diego, California in 1943 and CV-4 USS Ranger off Rhode Island in 1944. USS Ranger was the USN's first purpose-built aircraft carrier, launched on 25 February 1933 and commissioned at the Norfolk Navy Yard on 4 June 1934.

FROM AT-6 TO T-6, FROM TRAINING TO COMBAT

On 18 September 1947, the USAAF was disbanded and became an independent military service, the United States Air Force (USAF). All aircraft of the former USAAF were duly transferred to the USAF and aircraft designations were changed. The "P" designator, for "Pursuit", became "F" for "Fighter" (i.e., P-51 became F-51, etc.) and AT-6 "Texan" became T-6 "Texan".

THE GENESIS OF FORWARD AIR-STRIKE CONTROL

In Europe there were few situations where Allied and Nazi ground forces were so close or where the battle lines were so indistinct that it was necessary to closely guide air attacks to prevent "friendly fire"; however, The Battle of the Bulge (16 December 1944 - 25 January 1945) in Belgium was an exception. Near the end of the battle on 23 December when the stubbornly bad, socked-in weather finally began to open up so as to allow Allied air strikes, as well as much needed food, supplies, medicine and ammunition drops to the long- suffering besieged troops at Bastogne, forward radio position targeting from the ground to Allied aircraft made such drops and attacks effective and safe for Allied forces which were so proximate to Nazi forces.

In the Pacific, as mentioned in greater detail above, 4 Squadron of the RAAF deployed its Wirraways for forward air control at the Battle of Buna-Gona, New Guinea in November 1942. Achieving much success in this endeavour, the RAAF continued such operations throughout the war.

The USMC began to use ground- based forward air control during the Bougainville Campaign (November 1943 - November1944) and continued to refine it in subsequent actions until the war's end. Typically, USMC troops placed highly visible markers on the ground with arrows pointing toward Japanese positions and communicated with attacking Navy F6F "Hellcat" and Marine Corps F4U "Corsair" ground attack aircraft, aiding the accurate placing of bombs and rockets on Japanese targets which were dangerously close to U.S. forces.

In North Africa, British forces used what were called "Forward Air Control Links" which consisted of radio communications from troops at the front to distant bases at the rear requesting air support against nearby Nazi targets. The forward troops would then direct the attacking RAF aircraft (often Hurricanes with dual 40mm cannon and P-40s rigged to carry bombs). This successful system was later adopted by the USAAF and was put to good use during the Italian Campaign, and for the rest of the war.

T-6 IN THE KOREAN WAR

Virtually every USAF unit stationed in Korea during the Korean War (25 June 1950 - 27 July 1953) had at least one T-6 on hand and 97 of these were appropriately modified and quickly put to use in the combat theatre as Forward Air Controllers (FACS). Called "Mosquito", T-6s served with distinction as artillery spotters, and guides for all kinds of offensive aerial and ground operations. T-6s also participated in actual combat as night raider interceptors; and, as LT-6Gs with machine guns as well as ordinance firing and dropping capability installed, flew 40,000+ combat sorties against the armed forces of North Korea.

T-6G/SNJ-7

The last of the NA-16 series, T-6G/SNJ-7 was not, as one might assume, a planned, specifically designed and built NAA variant. It came about as a result of the precipitous and brisk selling of surplus USAAF AT-6s and SNJs immediately after the end of WWII.

Along with every other kind of military asset used to procure victory over the Nazis and the Empire of Japan, tremendous stocks of virtually every USAAF and USN/USMC aeroplane, in whatever condition, from never flown, to veteran, war weary, burned out hulks were put up on the block for surplus sale to the public in the summer of 1945.

In the United States, the War Assets Administration (WAA) and the Reconstruction Finance Corporation (RFC) were responsible for disposing of a total of 117,210 surplus aircraft. Deeming it too expensive to disassemble all of these aeroplanes or to store them, many were given to friendly foreign nations to build or re-build their air forces, some were transferred to U.S. Government agencies such as the Civil Aeronautics Authority (CAA) which became the Federal Aviation Agency (FAA) in 1958, and to the Air Force Auxiliary (Civil Air Patrol- CAP). A few famous ones (Enola Gay, etc.) went to museums and the rest were designated as either "obsolete" or "eligible for the strategic aircraft reserve".

Kingman AAF (Army Air Forces) in Arizona, Walnut Ridge AAF in Arkansas, and Ontario CAL-Aero Field in California were three of the largest depots for military aircraft ready to be either scrapped or sold. Altogether, 30 sales/storage and 23 sales centres were established.

As the USAAF, soon to be the USAF was rapidly transitioning to jet aircraft, most of their venerable veteran WWII aeroplanes were appropriately deemed obsolete. This included P-38, P-47, P-51 (for a while), Hellcat, Corsair (older models), B-17, B-24 and such. While a few examples of these "obsolete" aircraft were sold to civilians, and a few given to some government agencies, most of them, considered far too expensive to either re-build or to operate by most civilians, were scrapped for their aluminium after engines, propellers, radios, instruments and other useful parts were removed. Tens of thousands of precious aeroplanes went to the smelter[11]. Other types such as B-29, A-26 Invader, C-47, C-54 and, C-97 in good- to- new condition went to the USAF Reserve or were sold to airlines and other civilian operators.

Amongst the most popular surplus aircraft to be put upon the block was NAA AT-6 and SNJ.

Civilians quickly recognized that this aeroplane would not be so expensive to operate or as exotic to maintain as many other military types that were for sale and they snapped them up in great numbers for an average price of $500 ($500 in 1946 had the same buying power as $6,450.88 in 2015. Annual inflation over this period was 3.78%).

In 1948, the USAF and USN/USMC held an operational inventory of 5,780 T-6 and SNJ variants, 3,700 of which

Forward Air Control T-6 with phosphor rockets in Korea. USAF personnel developed their own rockets to visually mark targets. Seen here are fabricated rocket rails to attach rockets made from a 2.36-inch white phosphorus bazooka warhead attached to the front of a 2.25" aircraft practice rocket. Also attached is a 75 U.S. gallon fuel tank.

Seen in a number of Hollywood films made after WWII, including the epic story of the Japanese surprise attack at Pearl Harbor, "Tora! Tora! Tora!" (1970), AT-6s have often effectively masqueraded for the cameras as IJN Mitsubishi "Zeros". Aside from its authentic colour and markings, this one has also undergone a few structural cosmetic changes such as a modified and shortened canopy, a modified cowling, a "Zero-like" spinner and dorsal antenna, as well as a "Zero-like" extension to the bottom of its rudder.

Beautifully restored T-6G.

were flyable and many of which were posted with various States' Air National Guards, the USAF Reserve and CAP units. The upper echelons of the new-born USAF, recognizing that they required many more of these valuable and irreplaceable aeroplanes for training purposes than they now had on hand, regretted that they had put so many AT-6s up for sale and sought to recover them. This was the "T-6G Program".

NA-167/T-6G-NT

The USAF's "T-6G Program" was nothing more than getting back, from wherever possible, as many of those (too?) cheaply sold surplus AT-6s and SNJs that were essentially abandoned after the end of WWII as they could. It was surely somewhat embarrassing for the USAF to admit that they had virtually given away thousands of what were still very useful aeroplanes.

Once returned, these aeroplanes were to be shipped to NAA for a complete overhaul and re- manufacture into what would become the T-6G.

The "G" model was yet another improvement in this long-running series and was, in fact the last of the production T-6s. Changes included:

- A new canopy with less supporting structure to improve visibility.
- The rear seat was raised six inches so that the instructor had a better view of horizon.
- Installation of the latest radios.
- The hydraulic system was simplified and given a number of fail-safe provisions.
- Internal machine gun mounts were removed.
- A new tail wheel steering system was borrowed from NAA P-51: When the control stick is pulled aft of neutral, this locks the tail wheel steering. When locked, the tail wheel may be steered 6 degrees right or left by the rudder pedals. To make sharper turns, control stick forward of the neutral position unlocks the tail wheel allowing it to fully swivel. Differential braking is then required to steer.
- The rear position's instrument panel and important controls were now the same as those of the front position.
- Aerial masts were re-located.
- The propeller was upgraded to a "paddle" type, square-tipped propeller.
- The undercarriage and flap actuating levers were now the same as that of F-51 "Mustang".

As with all NA-16 variants, T-6G is stressed for a maximum positive-g of 5.67gs and a maximum negative g-load of -2.44gs. T-6G is capable of most aerobatic maneuvers with the exception of sustained inverted flight (because of engine cutoff). Snap rolls, outside loops, and inverted spins are prohibited.

T-6/SNJ IN FOREIGN SERVICE

As to the many AT-6/SNJs which were given to foreign nations, well… they were, of necessity, considered to be gone and no return of them for re-building was attempted. In the years immediately following the end of WWII, and for a long time thereafter, many of these now foreign- owned, armed AT-6s and SNJs were being effectively used to fight against strongly aggressive, militant anti- colonial rebellions and insurgencies that had arisen in many parts of the world. These conflicts seriously threatened the long- established colonial hold that some European nations had on third-world nations. Some of these conflicts were Communist inspired, armed and funded by the Soviet Union, and some were generated by independent, nationalist factions which had little or no Soviet involvement. Virtually all of them were the frustrated expression of people who wanted to free their countries from the often iron-fisted, exploitative rule of their European “masters”.

From the point of view of many in the United States government and military, aiding European allies and friends to defeat what was perceived to be a vast, global Communist threat was a high priority in the days of Senator Joseph McCarthy and in the “Soviet Containment” era. The “Cold War” (a phrase first written in “You and the Atomic Bomb”, a 1945 essay by George Orwell, born Eric Arthur Blair [25 June 1903 - 21 January 1950]) and the “arms race” had begun in earnest; accordingly, if a few handfuls of surplus T-6s might help to make the difference, it was thought just as well to leave them where they were.

A very weary and precious warhorse, this Israeli Air Force Harvard II flew in the 1948 War of Independence and in the 1956 Sinai Campaign against Egypt. At its inception in 1948, the Israeli Air Force was grateful to receive any aircraft that they could from generous benefactors. In those days a true potpourri of aircraft found their way to Israel, including this Harvard II and the 1947 Republic RC-3 “Seabee” amphibian (since then modified) seen here parked to its right.

Constantly in service as a trainer and a combat aeroplane in one area of the world or another since 1948, T-6s have proved their usefulness and worth to dozens of nations.

The following list is not exhaustive, but is illustrative of some of the post- WWII conflicts throughout the world in which T-6/SNJ/Harvard participated:

During The 1948 War of Independence, the Israeli Defense Force/Air Force, Kheil HaAvir, flew armed, ex-RAF Harvard IIs on missions of all kinds, including, ironically, aerial combat with Syrian Air Force armed AT-6s. Once again, in the 1956 Sinai War, the Israeli Air Force successfully deployed rocket firing and bomb dropping Harvard IIs against Egyptian mechanized forces.

From 1946- 49, during the Greek Civil War, three squadrons of armed British Harvard IIs and American T-6D and Gs served in the Royal Hellenic Air Force (RHAF).They performed multiple tasks including observation and artillery spotting, as well as close air support for the Greek Army. It is said that Communist guerrillas called these Harvards and T-6s “O Galatas” (“The Milkman”) because they patrolled very early in the morning. The guerrillas soon learned that soon after “The Milkman” left the area that they could expect attacks from RHAF Spitfires and Curtiss Helldivers.

Armed RAF Harvard IIs served in Kenya from 1952-1960 during the bloody Mau-Mau uprising, and also in Malaysia 1948-1951.

During the Algerian Insurrection Campaign (1954- 61), the French Armie de L’Air Algerie maintained a huge air force of at least thirty squadrons of AT-6s, SNJs and Harvards in Algeria, armed with under- wing machine guns, bomb attachment and release mechanisms, and rocket pods. Used primarily for counter-insurgence duty against rebellious Algerian forces, the French called their T- 6s “Tomcats”, or was it “Matou?”

In the first native rebellion in the Congo, Belgium employed numerous armed Harvards and T-6s to help to quell the uprising. When the Bels left the Congo they left their aircraft behind. The Government of the Congo thereafter utilised these aeroplanes during the Congolese Civil War (1960- 66).

In the 1960s the Portuguese Air Force used armed T-6s as their primary fighter/bomber against rebel forces in Angola, Mozambique and Portuguese Guinea.

A number of Laotian and Cambodian T-6s were used against the forces of North Vietnam in the 1960s.

Spanish Air Force T-6s saw action against North African rebel forces in the 1970s.

A NEW ROLE FOR AN OLD FRIEND

As mentioned, in 1949 the USAF commenced a county-wide campaign to buy back those AT-6s and SNJs that were often sold to the general public for as little as $400. They were able to buy back 1,802 of them at a cost of as much as $8,000 each (Americans recognise a sellers’ market when they see one). In batches of approximately 700 aeroplanes, AT-6s and a few SNJs were sent to NAA to be re-manufactured to T-6G standards most of which would be designated T-6G-NT to be

Heinkel HE178 V1 - The world's first turbo- jet- powered aeroplane.

The first flight of a jet engined aircraft to be recognised by the Fédération Aéronautique Internationale was the Italian Caproni Campini N.1 Motorjet which flew on 27 August 1940. The German Heinkel He 178 program then still being kept secret.

Gloster E28/39

used as a USAF Primary trainer.

T-6 a Primary trainer? Why the demotion?

Early in 1949, NAA began to plan for and design a replacement for the T-6G/SNJ-7. Accordingly, on 24 September 1949 NA-159/XT-28 was flown for the first time. The USAF and USN/USMC required a new set of training aircraft that would prepare cadets to fly the new jets that were gradually becoming first-line fighters and fighter/bombers. NAA's new T-28 filled the bill for a Primary/Basic trainer perfectly. While the entire U.S. military training curriculum in all services was drastically condensed after the end of the war, it was simultaneously being overhauled and modernized in all of the U.S. air services to suit the realities of the jet age. Aircraft which had formerly been sufficient as Basic and Advanced trainers were now clearly inadequate, if not antique.

Without any question, AT-6/T-6/SNJs had given exemplary service as Advanced trainers when propeller- driven aircraft such as P-51 and F4U were at the top of the aviation pyramid. We have seen above how crucial the Advanced flight training programme was to the ultimate Allied victory in WWII. However, even before the end of WWII, it had become clear that jet- powered aircraft were the wave of the future and that it would be necessary that future flight training aircraft reflect this new reality. Accordingly, a new training curriculum and new trainer aircraft which would aid cadets to bridge the vast difference in performance, handling, engine operations and flying techniques between propeller- driven and jet- driven aircraft were required.

THE DAWN OF THE JET AGE

In the years immediately before WWII, aeronautical engineers had come to realise that the propeller as a means of translating rotational engine power to thrust had natural limits — the speed of the propeller tips and the drag of the propeller disc in flight. It was understood that as an object approaches the speed of sound — Mach 1 (at sea level - assuming an air temperature of 59 degrees Fahrenheit [15 degrees Celsius] Mach 1 [M1] is 761.2 mph [1,225 km/h]) aerodynamic drag rises sharply as an object passes through the transonic regime

(M0.8 to M1: 600-768 mph [965-1236 km/h] at sea level). A propeller designed to operate at subsonic speeds will become less and less inefficient as it approaches transonic/supersonic speeds due to shock waves forming on the propeller tips' leading edges. The shock waves thus formed cause a drastic loss of efficiency due to the greatly increased drag which they produce. To further increase airspeed this increase in propeller tip drag must then be countered by greatly increasing power from the engine in a situation of ever- diminishing returns.

Even more dire than this, it is considered that the propeller's ability produce thrust (lift) falls very rapidly as the propeller's tip speed approaches the speed of sound. It is further considered that if the propeller's airfoil thickness- to- chord ratio (t/c) is above 15%, at M .887 the propeller tip airfoil's lift becomes negative. That is, the tip now creates forward (breaking) thrust.

Additionally, similarly to the trans-sonic propeller tip situation, the increasing drag of the propeller disc as airspeed increases produces an extreme inverse- efficiency condition which requires more and more power to increase thrust in ever smaller quantities (I'll spare you the math). For these reasons the propeller is a self- limiting device for generating sufficient thrust for extreme high- speed flight. It was theorised in the 1930s that airspeed in the vicinity of 500 mph or so was the upper limit for propeller driven aircraft and this

The shark-like and deadly Messerschmitt Me-262.

Gloster Meteor F8

proved to be remarkably accurate[12].

Accordingly, it was understood that another means of providing thrust was necessary to fly at higher airspeeds. Early experiments with gas-turbine engines led the way to the turbo-jet engine where incoming air is compressed, mixed with fuel and ignited.The burning mixture produces hot gases under pressure which are then passed through a turbine wheel and expelled producing rearward thrust. The compressor section is continually turned by the turbine wheel which extracts energy from the expanding gas passing through it. In this way a turbo-jet engine efficiently converts internal potential energy in the fuel to kinetic energy in the moving expelled air at the exhaust, producing thrust.

While the designs of elementary engines utilising rearward thrust date back many centuries, the first practical turbo-jet engine capable of powering an aeroplane is accredited to then Pilot Officer and later Air Commodore, Sir Frank Whittle, an RAF Officer and Cranwell College graduate, as well as an aeronautical engineer and test pilot, who, in 1928 submitted a practical design for a turbo-jet to the RAF. Securing private financial backing to develop, build and test his invention, the first "Whittle Jet", called the "W. U.", was up and running by April 1937. However, although immediately notified, the British Air Ministry was not yet interested.

A similar turbo-jet engine was designed in Germany by Hans von Ohan in 1935 who impressed aeronautical engineer and aircraft manufacturer, Ernst Heinkel with it. In 1937, Heinkel Flugzeugwerke designed and secretly flew the world's first turbo-jet powered aeroplane, Heinkel HE 178 V1.

The first British jet aeroplane was Gloster E.28/39 which first flew on 15 May 1941, powered by Pilot Officer Frank Whittle's W1 turbojet engine.

The concept of turbo-jet powered fighter/interceptor was developed and made practical by German engineers in the 1940s. The world's first operational jet fighter, Messerschmitt ME-262, shocked the Allies in June 1944 with its overwhelming speed and devastating firepower when it was deployed as a bomber interceptor. ME-262 was, in fact, too fast for Luftwaffe pilots to have sufficient time during an attack run to effectively fire at Allied bombers, and its range and endurance were very short. Allied fighters, which could never catch ME-262 in ordinary circumstances, were nevertheless able to destroy a good many of them by lurking about their home bases and hitting them when they slowed and approached for landing. Fortunately, there were not sufficient numbers of ME-262s available to the Luftwaffe to make a difference in the war's outcome. Herr Hitler ordered that they be re-designed for bomber duty which fatally interrupted Messerschmitt's assembly line until the Nazi's final and complete surrender on 8 May 1945.

Also in June 1944, RAF's Gloster Meteor F.1 and F.3 became the Allies' first and only operational jet fighter. However, it did not possess the speed and heavy armament of

ME- 262 and was primarily and successfully used as an interceptor of V-1 "Buzz bombs".

The disappointing USAAF Bell P-59 "Airacomet" flew in October 1942 but did not perform better than the best propeller- driven fighters at the time. Only 66 were built and P-59 did not become operational.

Lockheed's P-80 was more promising; however, during its early development phase both Lockheed's Chief Engineering Test Pilot Milo Burcham and the U.S.'s highest scoring ace in WWII, Medal of Honour winner Major Richard I. Bong were killed in separate accidents when their P-80's fuel pump failed on takeoff. By the time P-80 was ready to become operational, WWII was over.

From the first appearance in combat of ME-262, propeller- driven first- line fighter aircraft's days were numbered. U.S. and British manufacturers abandoned prospective propeller- driven fighter designs for jet designs. Accordingly, the the USAF, USN/USMC, RAF and RCAF's flight training curricula, and the aircraft they used for flight training, were radically and appropriately adjusted to accommodate the training requirements of the new jet age.

After WWII, military flight training in the U.S. went through a number of wrenching changes due to the massive de- mobilization of qualified flight instructors and the general contraction of the armed services. With the commencement of the Korean War on 25 June 1950, U.S. armed services and military flight training were greatly re-expanded and

Bell P-59 “Airacomet”.

Lockheed P-80.

USAF NA-159/T-28C replaced T-6G as an Advanced trainer in 1948.
T-28As were in USAF service between 1950-57 and were powered by an 800 hp Wright R-1300-7 radial engine driving a two- blade constant- speed propeller. The front and rear cockpits were identical as to instruments and controls and they closely replicated the jet aircraft cockpits of that time.

USN/USMC NA-159/T-28B replaced SNJ-7 as a Basic trainer in 1951. T-28B was powered by a 1,425hp Wright R-1820 radial engine driving a 3- blade constant-speed propeller and was in most other ways the same as the USAF’s T-28A. USN/USMC T-28C’s were identical to T-28Bs except that they had a retractable tail hook for aircraft carrier training.

T-34 two- seat military Primary trainer was derived from the famous Beechcraft four-seat Model 35 “Bonanza” airframe. T-34’s tall vertical fin/rudder was later seen on the Beechcraft “Travelair” twin.
The USAF and USN/USMC used T-34 as their Primary trainer beginning in 1953, replacing the aging T-6s. After more than seven decades, T-34 is still in active U.S. military service.

Originally designated F-80C, a two seat F-80 fighter, it was soon re-designated T-33 and commonly called “T- Bird”. The USAF and USN/USMC used T-33s as Advanced trainers in the early 1950s, continuing in service well into the 1980s.

remained so throughout the Cold War.

(The following years stated are approximate)

1945- 49: U.S. military flight training was greatly diminished after the end of WWII. In 1947 USAAF/USAF reduced cadet training from three to two phases – Primary/Basic using existing and re-manufactured T-6Gs, and Advanced training using the new NAA T-28A and Lockheed T-33(F-80C).

1950 - 52: With the commencement of the Korean War, U.S. military flight training was re-expanded to three phases: Primary- using T-6G, Basic- using T-28A (USAF) and T-28B (USN/USMC in 1951), and Advanced using T-33 (F-80C).

LATE 1952: Military flight training expanded to four phases- Pre-flight, Primary- T-6G, Basic- T-28A and B, Basic II (formerly Advanced)- T-33 and F-80, Crew Training- first-line aircraft (F-86, F-84, F9F, etc.)

1953: Primary- T-34 Mentor replaces T-6, Basic- T-28, Advanced- T-33, F-80, Crew Training- first- line fighters.

THE SUM OF ITS PARTS

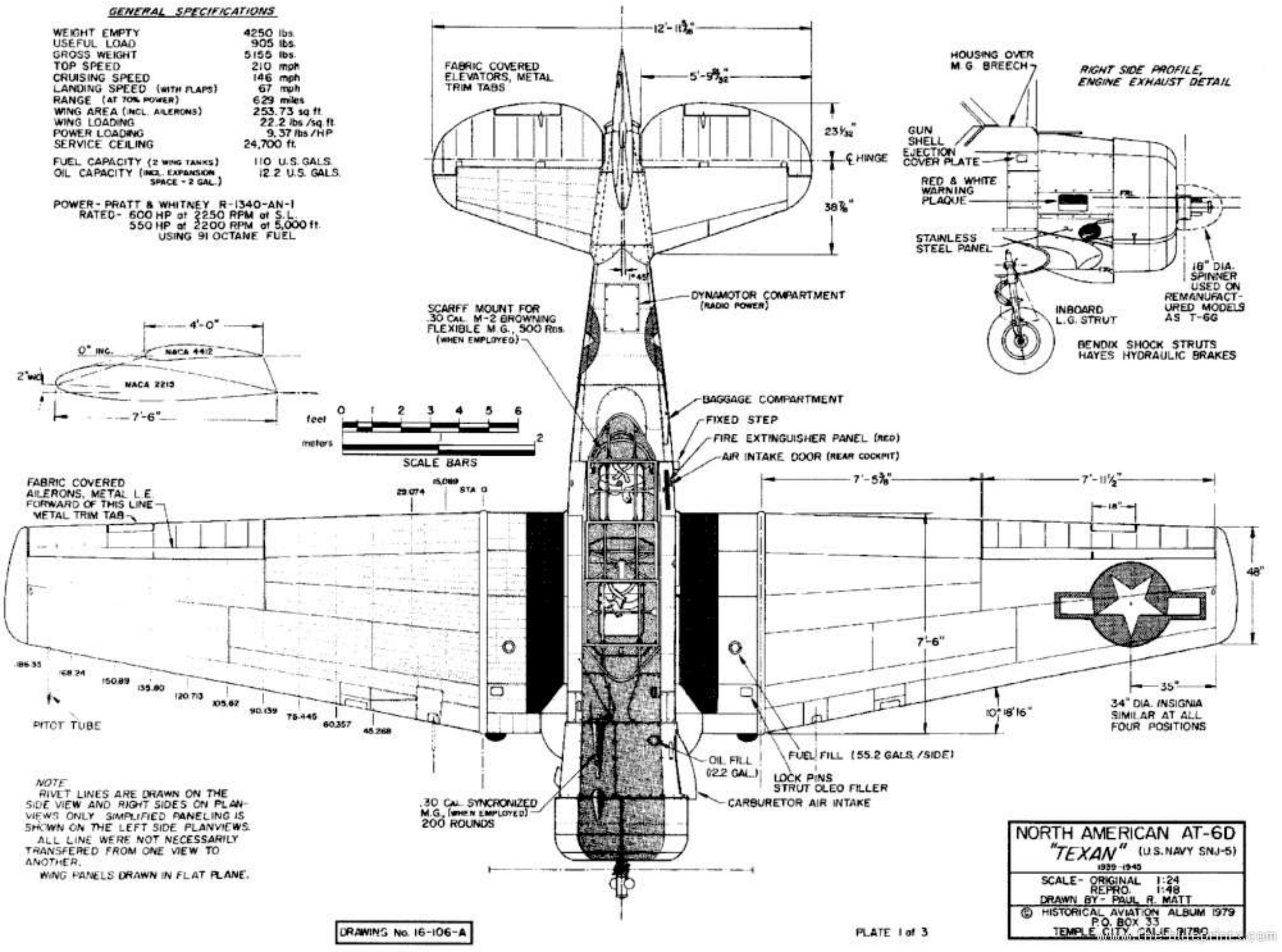
So, what literally are the nuts and bolts of an T-6G?

The fuselage is made up of a welded chrome-molybdenum steel-tube framework with various fittings and attachment points for the firewall/engine mount, fin, stabiliser and wing welded to the tubular structure. This truss type structure is stronger, more durable and most of all, easier (cheaper and quicker) to repair than a monocoque (French for "single hull) structure also called "stressed-skin" or "structural skin". Given that this aeroplane role is that of a trainer, which intrinsically implies that the pilots of same are mostly not yet so expert that they will not occasionally roughly handle it, a durable and easy to repair structure is clearly requis.

FUSELAGE

The fuselage is constructed of four bolted-together sections:

1. Forward of the firewall: The propeller with hydraulic constant- speed actuator and housing, engine, integrated oil tank, engine mounts and cowling attachment points;



2. The cockpit and centre fuselage section: Mostly constructed of welded steel tubing fared with removable aluminium panels for ease of maintenance and repair, attached to the sub-structure with aircraft- grade machine screws; thick, steel, flame resistant firewall, high- g cockpit floor with two pilots' seat attachment fittings, integrally welded chrome steel roll-over cage, provision for and heavy attachment fittings for the wing centre section, provision for control rods, cables, etc. to enter and exit, 360 degree- vision canopy and canopy/fuselage attachment points, centre flap attachment points and hinges, centre split-type flap consisting of an aluminium alloy frame covered with aluminium alloy stressed- skin, in some variants a single, fixed, Browning .30 calibre machine gun mount in decking in front of and to the right side of the front cockpit structure, and a stowable, flexible, rearward facing, single Browning M-2 .30 calibre machine gun on a flexible Scarf mount aft of the rear seat;

3. Tail section: Fin and stabilizer attachment fittings, fixed tail wheel assembly fittings;

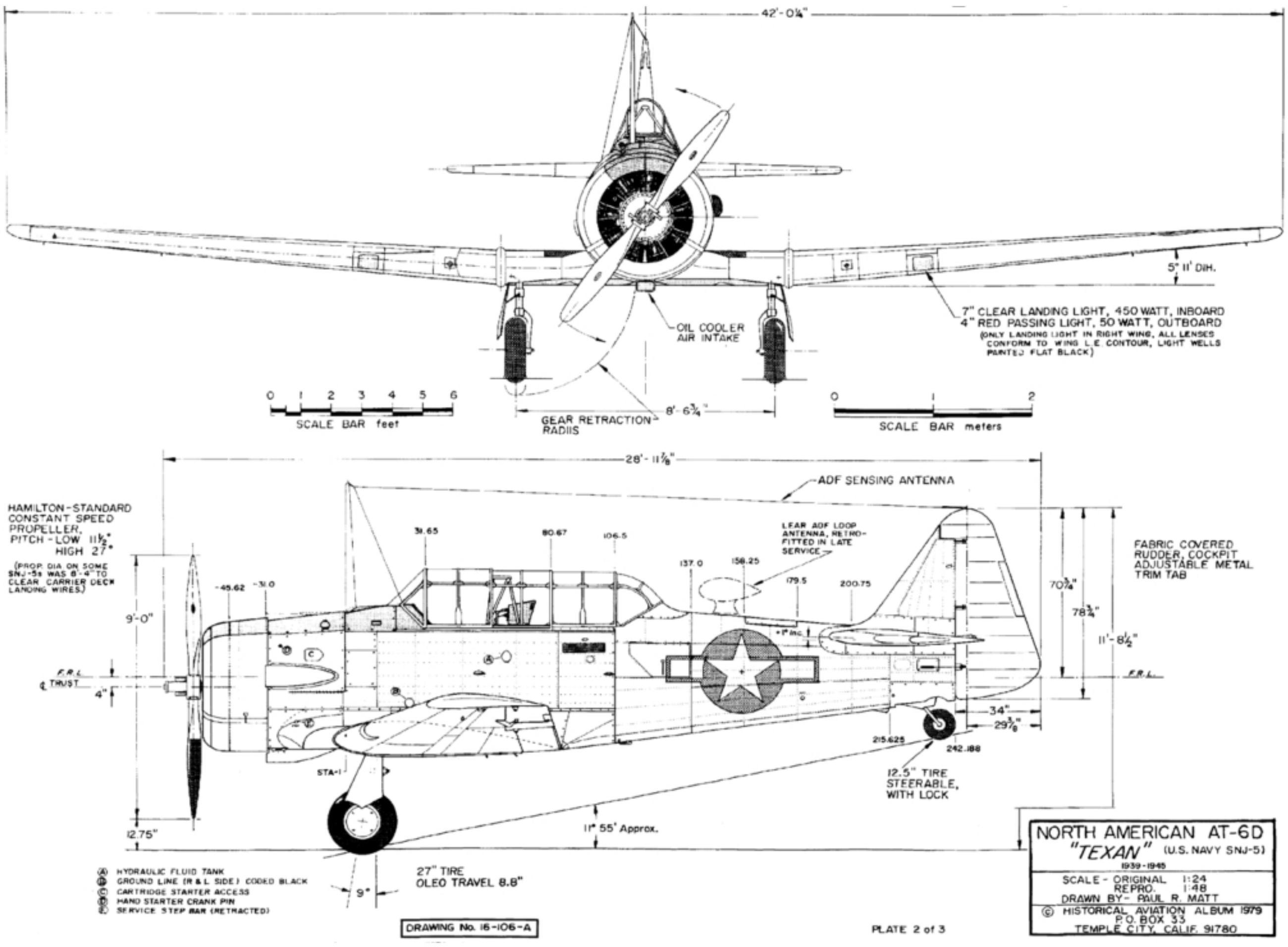
4. Ventral section (bottom, aft of the wing): Stressed- skin structure for reduced weight, additional fixed tail wheel assembly fittings.

WING

The AT-6/T-6 cantilever monoplane wing airfoils are NACA 2215 at the wing root and NACA 2209 at the wing tip. The wing consists of five bolted- together sections:

Section 1. The centre section is a steel and aluminium alloy truss/semi stressed skin structure, rectangular (constant chord and depth) mounted beneath the fuselage and faired thereto with light aluminium sections attached with aircraft- grade machine screws, two individual, removable fuel cells of 70 U.S. gallons each, retractable undercarriage assembly including hydraulic retracting and extension actuators and motors, attachment fittings for outer wing panels.

Sections 2-3. The left and right outer wing panels are each attached to the centre section, tapered from root to tip both in planform and depth with a swept leading edge and slightly swept forward trailing edge. Each outer wing is set at 5º 11' dihedral. The outer wing panels are a single spar with stamped aluminium ribs, aluminium alloy stressed- skin



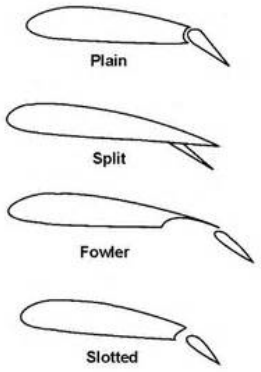
T-6G 49-2908. One of the original T-6G conversions, this aircraft after seeing service with the USAF was placed on the gate at Davis Monthan AFB in the 1970s, before being displayed at the Pima Air Museum.

covered structure with attachment fittings to the centre section, and with attachment fittings and hinge points for one split- type flap. Each flap is constructed of an aluminium alloy frame with ribs covered with stressed- skin aluminium alloy. Each outer wing panel also accommodates one hinged and dynamically balanced, fabric covered (butyrate doped reinforced linen) aileron constructed of aluminium alloy frames and ribs. Each aileron has a ground- adjustable trim tab which is not adjustable from the cockpit.

TYPES OF FLAPS

Sections 4-5. Left and right wing tips: Aluminium alloy frames covered with an aluminium skin attached to each outer wing panel with machine screws.

Removable inspection plates are provided in strategic places on the wing for visually inspecting attachment points, hinge assemblies and internal structure.



FIN AND STABILIZER

The vertical fin is constructed of light alloy aluminium, is tapered and is covered with a light aluminium alloy skin with attachment points to the aft fuselage and is offset 2° to the right to counter left turn propeller effect called “P- factor” (not torque as often erroneously stated), hinged to accept the rudder and attached to the fuselage with aircraft- grade machine screws.

The left and right stabilizers are cantilever, are tapered and are constructed of light aluminium alloy frames and ribs covered with stressed-skin panels attached to the fuselage with aircraft- grade machine screws. The left and right stabilizers are interchangeable and hinged to accept the left and right elevators which are also interchangeable. Removable inspection plates are provided in strategic places for visually inspecting attachment points, hinge assemblies and internal structure.

RUDDER AND ELEVATORS

Both the rudder and left and right elevators are dynamically balanced and constructed of light aluminium alloy frames and ribs covered with fabric (butyrate doped reinforced linen).

The rudder has one cockpit- adjustable trim tab and each elevator has one inter- coordinated, cockpit- adjustable trim tab.

RETRACTABLE UNDERCARRIAGE AND TAIL WHEEL

The retractable main undercarriage consists of a left and right cantilever oleo strut, oleo travel is 8.8”. Attached to each oleo strut is one 27” pneumatic wheel. The upper ends of each oleo strut are connected to hydraulic actuators located near each forward outboard end of the wing centre section, which are bolted to the internal structure of the wing centre section and which rotate each oleo strut and wheel inward to retract and outward to extend. Each retracted strut and wheel is held in place by a positive mechanical up- lock which can be released from the cockpit in the event of the failure of the hydraulic undercarriage extend system. Each extended oleo strut is locked down after extension until the undercarriage control handle in the cockpit is moved to the "retract" position. Attached to each oleo strut is a flat aluminium door which sits flush with the underside of the wing centre section when the undercarriage is retracted to minimise drag (removed in some Harvard variants). The right and left undercarriage units are interchangeable. Later version USN SNJ's equipped for aircraft carrier service have a tail wheel lock which sets it straight ahead. When so locked, steering is then accomplished by differential braking.

Main wheel brakes are independently hydraulically-operated from the tops of the rudder pedals and may be simultaneously applied in the cockpit for parking and engine run up. RAF and RCAF Harvards have control column hand- grip braking controls.

The fixed, oleo-sprung steerable 12.5" tail-wheel may be pneumatic or solid rubber and is steerable 6 degrees to either side from the rudder pedals when the control stick is pulled aft of neutral. The tail wheel's limited rudder pedal steering mechanism is disconnected when the control stick is pushed forward of neutral which permits the tail wheel to freely swivel for tighter turning. In swiveling mode, steering is by the application of differential main undercarriage brakes. AT-6 and earlier variants had only free swiveling, differential- brake tail wheel steering.

ENGINE PROPELLER AND FUEL SYSTEM

The aeroplane is powered by one Pratt & Whitney nine-cylinder radial, air-cooled "Wasp" R-1340-S1H1 engine, developing 550-600 hp at 5,000 ft (1,525 m). It is mounted by bolts with vibration- reducing pads to the front of the fuselage by welded chrome-molybdenum steel-tubes. The engine is offset negative 4° in pitch. The NACA aluminium cowling is attached to a frame in the forward fuselage by quick-removable Dzus-type fasteners. The propeller is a Hamilton Standard hydraulically actuated, cockpit adjustable, constant- speed type, 9' in span and has a 12.75" ground clearance when the aeroplane is at level attitude. Fuel supply consists of two fuel cells located in the wing centre section located on each side of fuselage. Normal fuel capacity is a total of 140 U.S. gallons. The oil tank (9.5 U.S. gallons) is located in the engine compartment and is detachable with the engine as a unit.

A fairly prolific aircraft design, a total of 17,096 aircraft stemming from the original

NA-16 were built by North American Aviation in California and Texas, as "Harvard" in Montreal by Noorduyn, in Fort Frances, Ontario by Canadian Car and Foundry, and in Australia as "Wirraway" by the Commonwealth Aircraft Corporation (CAC).

13,685 of these were of the AT-6/SNJ series built in the Unites States in the 1940s. This is very near the same as the total number of Beechcraft "Bonanzas" built as of 2016.

THE A2A T-6G

Every bit of Scott Gentile's brilliant and revolutionary "Accu-Sim" matrix, plus a few new bits of simulator "magic" have been employed to make the A2A T-6G the finest, most accurate and authentic home flight simulator aeroplane available anywhere. You will find that our T-6G feels uncannily "real" in all operations whether on the ground or in the air; and, of course, it performs exactly by the book.

More than just that, the A2A T-6G's handling on the ground and in the air is not based upon guesses or even upon previously published pilot's reports. We are fortunate to have a number of AT-6/SNJ/T-6 pilots on our Beta team who have informed us, in great detail, of the specific and unique handling characteristics of T-6G. Among them is A2A's senior advisor and test pilot, Dudley Henriques, a celebrated, world -famous warbird pilot who has approximately 200 hours in SNJ-5s and T-6Gs as a flight instructor and check pilot. Additionally, Scott Gentile himself, who is an Instrument rated Private Pilot has logged numerous hours of dual instruction in restored T-6Gs and even obtained his FAA tail wheel endorsement in a T-6G, which is quite remarkable and unusual.

A2A's T-6 features accurate and detailed engine and propeller performance, sound and even every shake and vibration that they impart to T-6Gs airframe — all perfectly and realistically simulated.

Extensive sound recordings of every control, switch and everything that makes a sound in a real T-6G have been imported into this simulation.

We are proud to say that A2A's exclusive visual artists are the very best in the business.They have provided A2A's simulation of T-6G with the most accurate and authentic flight simulator model of this aeroplane ever offered, both inside and out. Even when viewed closely, A2A's T-6G never "fuzzes out", but remains a true fractal image of the aeroplane as it exists in the real world.

As with all A2A "Accu-sim" aircraft, our T-6G is fully configurable with regard to fuel, oil, and passenger load. In the extensive repair and inspection hanger, new spark plugs may be installed and the oil may be changed, the engine may be inspected and each separate component, internal and external may be replaced. The engine's cylinders may be checked for proper compression, and the entire engine may be overhauled if desired. Additionally, if any part of the airframe becomes damaged, it will be duly reported in the hanger where it may be repaired.

These, and many, many more features are part of the A2A T-6G experience, all of which exist to increase your immersion in, and fascination with, this historic and fun- to- fly aeroplane.

Come with us and share our passion for flight.

FOOTNOTES FOR THIS CHAPTER

1 The first organised U.S. air force was the Aeronautical Division, Signal Corps from 1 August 1907 to 18 July 1914, followed by the Aviation Section, Signal Corps 18 July 1914 to 20 May 1918 and the Division of Military Aeronautics, 20 May 1918 to 24 May 1918. Thereafter, the United States Army Air Service was established 24 May 1918 until 2 July 1926 when it became the United States Army Air Corps (USAAC). On 20 June 1941 the United States Army Air Forces (USAAF) was established to essentially take over the role of the USAAC; however, the USAAC remained as a combat arm of the U.S. Army supporting ground operations until it was disbanded on 18 September 1947 when the USAAF became the United States Air Force (USAF).

2 An additional reason for the name "Texan" may be that during WWII NAA opened a second plant in Grand Prairie, TX, known as "The Dallas Plant".

3 "FS" stands for "Federal Standard 595A, B and C", also called "FED-STD-595", a certified standard U.S. registry of colours available as paint chips most commonly available in a "fan deck". The initial standard FED-STD-595 issued in March 1956 contained 358 colors. Revision A issued in January 1968 included 437 colors. Current Revision B Change 1 from January 1994 contains 611 colors. Federal Standard 595C was published January 16, 2008. No previous colors were removed and thirty-nine new colors were added for a total of 650 colors. On July 31, 2008 595C Change Order 1 was published, changing the numbers of eight of the colors which were added in revision C. All FS numbers herein refer to FED-STD-595 C- 1.

Since the Federal Standard 595 system did not exist in the WWII era, comparisons of paint colours from that time with modern FS chips is always an approximation. For instance, there is apparently no single FS chip that is a perfect representation of Olive Drab 41. Fortunately, accurate paint ships from that and earlier times still exist and are readily available in a number of publications for colour identification.

4 The 24th edition of "Etymologisches Wörterbuch der deutschen Sprache" (2002) says the word Nazi was favoured and possibly coined in southern Germany (supposedly from c.1924) among opponents of National Socialism because the nickname Nazi, Naczi (a distortion of the masculine proper name Ignatz, a German form of Ignatius meaning "ardent, burning". Saint Ignatius of Loyola was the founder of the Catholic Jesuit order) was used colloquially in Germany to mean "a foolish person, clumsy or awkward person." Ignatz was a popular first name in Catholic Austria and according to one source in World War I, Nazi was a generic name in the German Empire for the less than admired soldiers of Austria-Hungary.

5 The A6M was designated as the "Mitsubishi Navy Type 0 Carrier Fighter" (零式艦上戦闘機 rei-shiki-kanjō-sentōki?), or the Mitsubishi A6M Rei-sen. Having entered service with the Imperial Navy in the Imperial year 2,600 (1940) the "Reisen" or "Zero" fighter gets its name from the last digit of that year.

6 Very few U.S. fighter aircraft had enclosed cockpits prior to the P-35 — Curtiss XP-31, Boeing P-29 as examples, but these were experimental and were not put into production. Also, U.S. Navy's Grumman FF-1, a two seat attack aircraft introduced in 1933 had both an enclosed cockpit and retractable undercarriage, although it was a biplane. Additionally, a few civilian aircraft notably the Northrop "Gamma" which design was to play a role in the NA- 16, had an enclosed cockpit in the early 1930s.

7 Of course, a swept- back wing also delays shock waves and the accompanying aerodynamic drag rise caused by fluid compressibility near the speed of sound and has long been universally accepted as an important feature of modern jet aircraft design; however, this was not yet a practical consideration for aeronautical engineers in the 1930s.

8 NA-64 cost approximately $14,000.00 in 1936 which is approximately the same buying power as $234,812.00 in 2015. Annual inflation over this period was 3.65%.

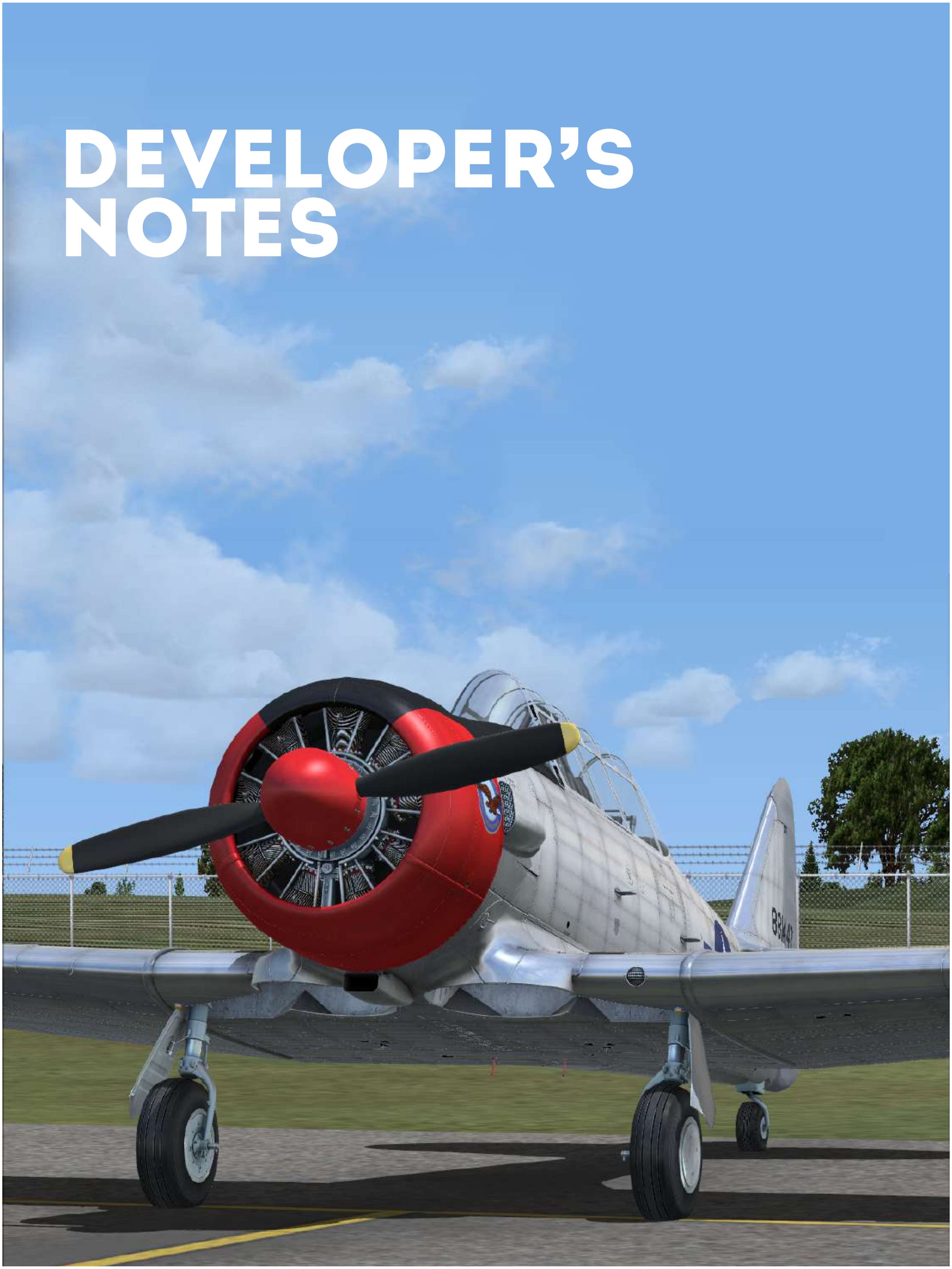
9 Reynolds Number: R = Vc / v where V is the true airspeed, c is the chord (average distance from a wing's leading to trailing edge), and v is the kinematic viscosity of the fluid in which the airfoil operates, which is 1.460x10-5 m2/s for the atmosphere at sea level.

10 The "AT" designation had not been used in the USAAC since the 1924 Huff –Daland TW-5, re- designated AT- 1 biplane trainer. Originally formed in 1920, the Ogdensburg Aeroway Corp. was renamed the Huff-Daland Aero Corp. and in 1924 the Huff-Daland Company. In 1927, the Huff-Daland Company became a part of Keystone Aircraft Company. In 1931, Keystone had become the Keystone Aircraft Division of the Curtiss-Wright Corporation.

11 When I was a young boy in the '50s, we lived near a large smelter. A great part of its business was to break-up and smelt wrecked aeroplanes brought in from local airports and military air bases. There was a field in which they would store these hulks until they were ready to be smelted, and it was unguarded against the intrusions of young boys. Whenever I wanted to I would play in and out of all kinds of aircraft, from airliners to jet fighters and bombers for hours on end, not at all realising what a special, precious and unique experience I was having. During the course of my uninhibited "discoveries" I even learned a few things about aircraft structures and such that kept me in good stead later on.

12 As of this writing, the official speed record for a piston- powered propeller- driven aeroplane is held by a highly modified Grumman F8F "Bearcat", the Rare Bear, which attained an airspeed of 528.31 mph (850.24 km/h) on 21 August 1989 at Las Vegas, Nevada.

DEVELOPER'S NOTES



The T-6 Texan is an aircraft that has changed the lives of so many pilots over the past seventy years. It was the final step before flying the highest powered WWII fighters and today, it is still changing lives because it inspires while it teaches.

The Texan holds a special place in world history, as it trained a generation of combat pilots how to fly a complex and high performance piston powered airplane. Additionally the T-6 uses a tail wheel instead of a nose wheel (tricycle gear) which requires additional training over a tricycle style gear system common on airplanes today. To fly a T-6, a pilot must train and receive a complex, high performance, and tail wheel endorsement.

But the T-6 is well beyond these endorsements, as it is a large and heavy aircraft with a high wing loading (high weight relative to the size of the wing). And beyond this, the T-6 is one of the hardest aircraft to master. This difficulty is what makes a T-6 keep it’s pilot at arm’s reach, especially during training. This means that when you fly a T-6, a pilot must always bring his or her “A game.”

Perhaps the most difficult aspect of operating a T-6 is maintaining positive control after the wheels touch down on landing. There is a lot of weight behind the contact points of the wheels, which wants to swing around as the plane is slowing down. This requires the pilot to either plant the tail down during a slower 3-point landing (a landing where all three wheels touch down at roughly the same time) or hold the tail up high into the air stream on a faster wheel landing (touching down on the main wheels in a level pitch attitude). The worst thing a pilot can do is land a “Six” with the tail hanging low, but not touching the ground because the rudder is ineffective when it’s low and directly behind the fuselage and the tail wheel isn’t giving any directional stability.

Countless experienced pilots have ground-looped (tail swings around on the ground) a T-6 on landing. So the Texan’s reputation precedes itself and if she could speak, she might say something like “if you are going to fly me, you better treat me right.”

In the air, the T-6 also has an ability to suddenly, with little warning, drop a wing when in the stall. Some pilots have unfortunately lost their lives on the final turn to landing when they either got too slow or pulled back too hard, which caused the inside wing to drop and without altitude to recover, ended up impacting the ground usually in a very bad attitude.

Pilots are human, which means we’re not perfect. And this imperfection brings with it a risk when flying an aircraft like the T-6 Texan. You must give the aircraft all the respect she demands and deserves.

The T-6 Texan is an iconic aircraft, like no other, that has both inspired and challenged pilots since the day it was created until today and beyond. We at A2A Simulations are proud to have brought this timeless icon into the world of Accu-Sim, where you can experience this aircraft in ways never done before.

A2A Simulations Team

A2A simulations

FEATURES

- A true propeller simulation
- Pratt & Whitney R-1340 supercharged radial engine captured and physically reproduced
- Both the front and rear cockpits and the entire aircraft gorgeously constructed with real-to-life materials
- Physics-driven sound environment
- Complete maintenance hangar internal systems and detailed engine tests including compression checks
- Visual Real-Time Load Manager
- Extensively flight tested the actual aircraft first hand by A2A Simulations pilots against the simulation
- Accu-Sim fluid flight modeling allows for aerobatics including accelerated stalls, snap rolls, and hammerheads
- Hyper realistic engine vibrations and harmonics pass through the airframe including the shock mounted cockpit panels
- True to life ground handling, makes landings forever challenging, just like the real T-6. You can hear and feel the large tires bite into the pavement
- Hand propping
- Towing
- Three different canopies can be selected in real time
- Propeller hub can be removed, revealing a working propeller governor inside
- Piston combustion engine modeling. Air comes in, it mixes with fuel and ignites, parts move, heat up, and all work in harmony to produce the wonderful sound of a big radial engine. The gauges look beneath the skin of your aircraft and show you what Accu-Sim is all about
- Authentic avionics with built-in, automatic support for many popular 3rd party avionics
- Digitrak autopilot with altitude hold reproduced by the book
- Optional direct cranking or direct inertial starter options included
- Dynamic ground physics including both hard pavement and soft grass modeling. Grass landings are a lot of fun, just like in the real T-6.
- Primer-only starts
- Persistent airplane even when the computer is off.
- Naturally animated pilot and co pilot with optional sunglasses, standard headphones or helmets
- 3D Lights 'M' (built directly into the model)
- Pure3D Instrumentation
- In cockpit pilot's map
- Authentic fuel delivery includes priming and proper mixture behavior. Mixture can be tuned by ear
- A2A specialized materials with authentic metals, plastics, and rubber.
- Oil pressure system extensively simulates oil that moves from the tank, through the pumps, into the engine, to the prop, into the cylinders, and even can even drain down into an included oil clean kit when attached when the engine is off (works even when the computer is off). Oil is affected by viscosity (oil thickness). Oil viscosity is affected by oil temperature. Now when you start the engine, you need to be careful to give the engine time to warm.
- Ten commercial aviation sponsors have supported the project including Phillips 66 Aviation, Champion Aerospace, and Knots2u speed modifications.
- And much more ...

QUICKSTART GUIDE

Chances are, if you are reading this manual, you have properly installed the A2A Accu-Sim T-6 Texan. However, in the interest of customer support, here is a brief description of the setup process, system requirements, and a quick start guide to get you up quickly and efficiently in your new aircraft.

SYSTEM REQUIREMENTS

The A2A Simulations Accu-Sim T-6 Texan requires the following to run:

- Requires licensed copy of Lockheed Martin Prepar3D

OPERATING SYSTEM:

- Windows XP SP2
- Windows Vista
- Windows 7
- Windows 8 & 8.1
- Windows 10

PROCESSOR:

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

HARD DRIVE:

250MB of hard drive space or better

VIDEO CARD:

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

OTHER:

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

INSTALLATION

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

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

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

REALISM SETTINGS

The A2A Simulations Accu-Sim T-6G was built to a very high degree of realism and accuracy. Because of this, it was developed using the highest realism settings available in Lockheed Martin Prepar3D.

The following settings are recommended to provide the most accurate depiction of the flight model. Without these settings, certain features may not work correctly and the flight model will not perform accurately. The figure below depicts the recommended realism settings for the A2A Accu-Sim T-6G.

FLIGHT MODEL

To achieve the highest degree of realism, move all sliders to the right. The model was developed in this manner, thus we cannot attest to the accuracy of the model if these sliders are not set as shown below.

INSTRUMENTS AND LIGHTS

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

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

ENGINES

Ensure "Enable automixture" is NOT checked.

FLIGHT CONTROLS

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

ENGINE STRESS DAMAGES ENGINE

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

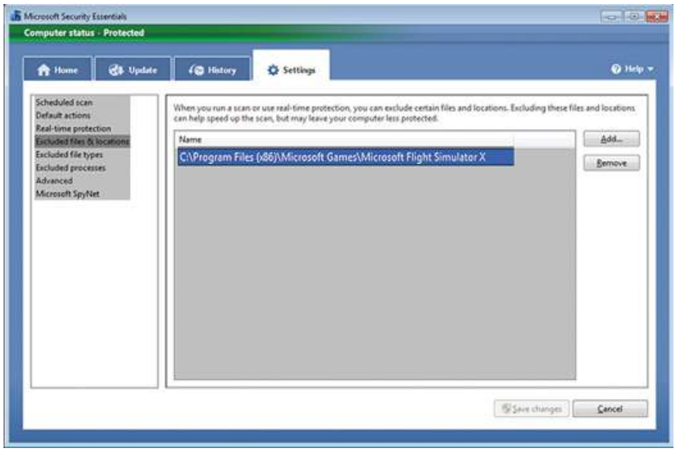
DISPLAY SETTINGS

Under Aircraft, "High Resolution 3-D cockpit" must be checked.

NOTE: It is recommended that the aircraft is NOT set as the default aircraft/flight in P3D.

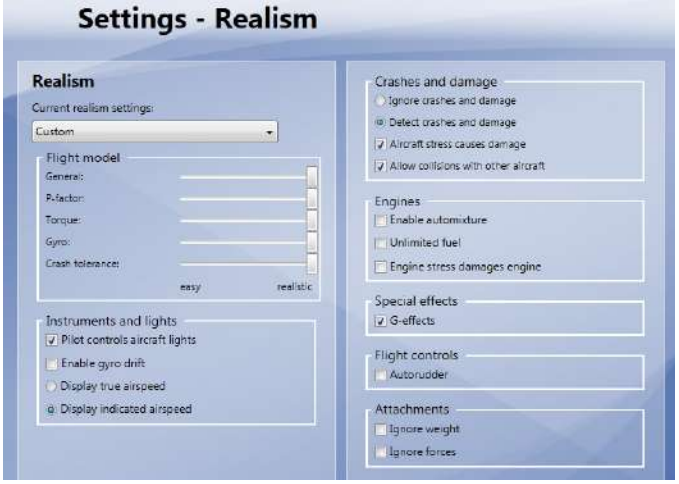
SUPPORT AND QUESTIONS?

Please visit us and post directly to the A2A support and community forums; https://a2asimulations.com/forum/index.php



When you run a scan or use real-time protection, you can exclude certain files and locations. Excluding these files and locations can help speed up the scan, but may leave your computer less protected.

C:\Program Files (x86)\Microsoft Games\Microsoft Flight Simulator X



Settings - Realism

Realism

Current realism settings: Custom

Flight model
General:
P-factor:
Torque:
Gyro:
Crash tolerance:

Instruments and lights
☑ Pilot controls aircraft lights
☐ Enable gyro drift
○ Display true airspeed
● Display indicated airspeed

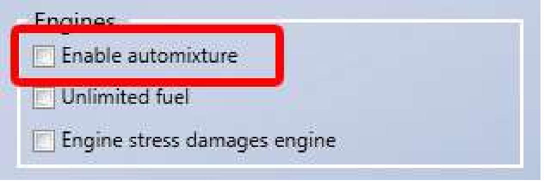
Crashes and damage
○ Ignore crashes and damage
● Detect crashes and damage
☑ Aircraft stress causes damage
☑ Allow collisions with other aircraft

Engines
☐ Enable automixture
☐ Unlimited fuel
☐ Engine stress damages engine

Special effects
☑ G-effects

Flight controls
☐ Autorudder

Attachments
☐ Ignore weight
☐ Ignore forces



Engines
☐ Enable automixture
☐ Unlimited fuel
☐ Engine stress damages engine

QUICK FLYING TIPS

- To Change Views Press A or SHIFT + A.
- Keep the engine at or above 800 RPM. Failure to do so may cause spark plug fouling. If your plugs do foul (the engine will sound rough), try running the engine at a higher RPM. You have a good chance of blowing them clear within a few seconds by doing so. If that doesn't work, you may have to shut down and visit the maintenance hangar.
- On landing, once the airplane settles slowly pull back on the yoke for additional elevator braking while you use your wheel brakes. Once the airplane has slowed down you can raise your flaps.
- Be careful with high-speed power-on dives (not recommended in this type of aircraft), as you can lose control of your aircraft if you exceed the max allowable speed.
- For landings, take the time to line up and plan your approach. Keep your eye on the speed at all times.
- Using a Simulation Rate higher than 4× may cause odd system behavior.
- A quick way to warm your engine is to re-load your aircraft while running.
- In warm weather, use reduced power and higher speed, shallow climbs to keep engine temperatures low.
- Avoid fast power reductions especially in very cold weather to prevent shock cooling the engine.

FOR SIMULATION USE ONLY

ACCU-SIM AND THE T-6 TEXAN

Accu-Sim is A2A Simulations' growing flight simulation engine, which is now connectable to other host simulations. In this case, we have attached our Accu-Sim T-6 Texan to Lockheed Martin Prepar3D to provide the maximum amount of realism and immersion possible.

WHAT IS THE PHILOSOPHY BEHIND ACCU-SIM?

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

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

ACTIONS LEAD TO CONSEQUENCES

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

YOUR AIRCRAFT TALKS

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

BE PREPARED – STAY OUT OF TROUBLE

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

So, piloting an aircraft requires both precision and respect of the machine you are managing.

It is important that you always keep an eye on your oil pressure and engine temperature gauges. On cold engine starts, the oil is thick and until it reaches a proper operating temperature, this thick oil results in much higher than normal oil pressure. In extreme cold, once the engine is started, watch that oil pressure gauge and idle the engine as low as possible, keeping the oil pressure under 100psi.

PERSISTENT AIRCRAFT

Every time you load up your Accu-Sim T-6 Texan, you will be flying the continuation of the last aircraft which includes fuel, oil along with all of your system conditions. So be aware, no longer will your aircraft load with full fuel every time, it will load with the same amount of fuel you left off when you quit your last flight. You will learn the easy or the hard way to make, at the very least, some basic checks on your systems before jumping in and taking off, just like a real aircraft owner.

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

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

Airframe:	North American T-6G	0.0 hrs
Engine:	Pratt and Whitney radial model R-1340-AN-1	0.0 hrs
Prop:	Hamilton Standard 12D40 constant speed 2-blade	

Report
General Condition: ...like new.

Notes...

SOUNDS GENERATED BY PHYSICS

Lockheed Martin Prepar3D, like any piece of software, has its limitations. Accu-Sim breaks this open by augmenting the sound system with our own, adding sounds to provide the most believable and immersive flying experience possible. The sound system is massive in this Accu-Sim T-6 Texan and includes engine sputter / spits, bumps and jolts, body creaks, engine detonation, runway thumps, and flaps, dynamic touchdowns, authentic simulation of air including buffeting, shaking, broken flaps, primer, and almost every single switch or lever in the cockpit is modeled. Most of these sounds were recorded from the actual aircraft and this sound environment just breaks open an entirely new world. However, as you can see, this is not just for entertainment purposes; proper sound is critical to creating an authentic and believable flying experience. Know that when you hear something, it is being driven by actual system physics and not being triggered when a certain condition is met. There is a big difference, and to the simulation pilot, you can just feel it.

GAUGE PHYSICS

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

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

LANDINGS

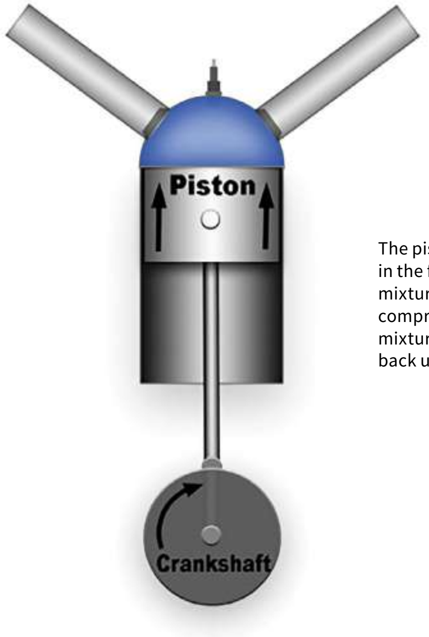
Bumps, squeaks, rattles, and stress all happens in an aircraft, just when it is taxiing around the ground. Now take that huge piece of lightweight metal and slam it on the pavement. It's a lot to ask of your landing gear. Aircraft engineer's don't design the landing gear any more rugged than they have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

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

YOUR TURN TO FLY SO ENJOY

Accu-Sim is about maximizing the joy of flight. We at A2A Simulations are passionate about aviation, and are proud to be the makers of both the A2A Simulations Accu-Sim T-6 Texan. Please feel free to email us, post on our forums, or let us know what you think. Sharing this passion with you is what makes us happy.

ACCU-SIM AND THE COMBUSTION ENGINE



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

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

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

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

OVERVIEW OF HOW THE ENGINE WORKS AND CREATES POWER

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

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

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

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

AIR TEMPERATURE

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

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

MIXTURE

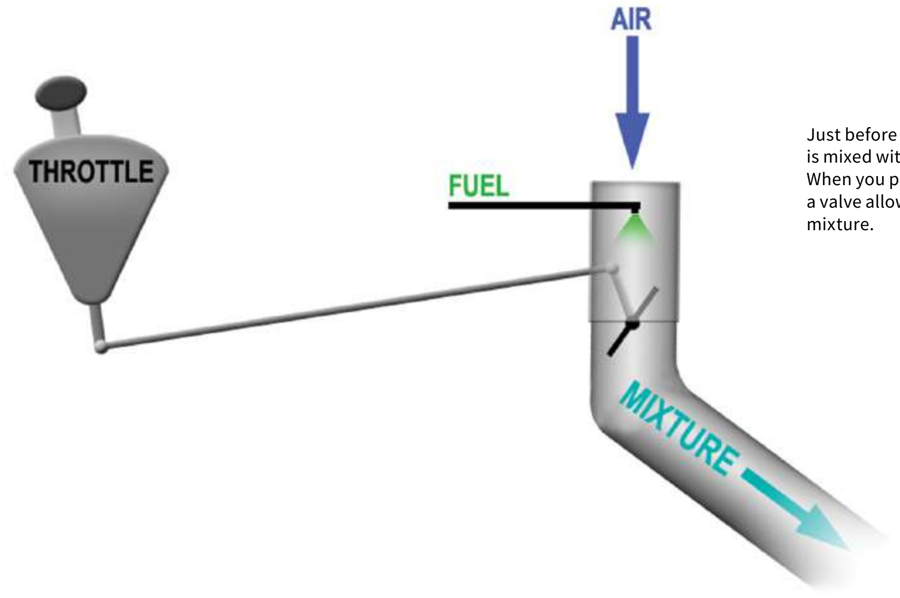
Just before the air enters the combustion chamber it is mixed with fuel. Think of it as an air / fuel mist.

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

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

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

However, since the engine at high power will be nearing



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

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

So, think of it this way:

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

THE MIXTURE LEVER

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

HOW DO YOU KNOW WHEN YOU HAVE THE RIGHT MIXTURE?

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

INDUCTION

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

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

MANIFOLD PRESSURE = AIR PRESSURE

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

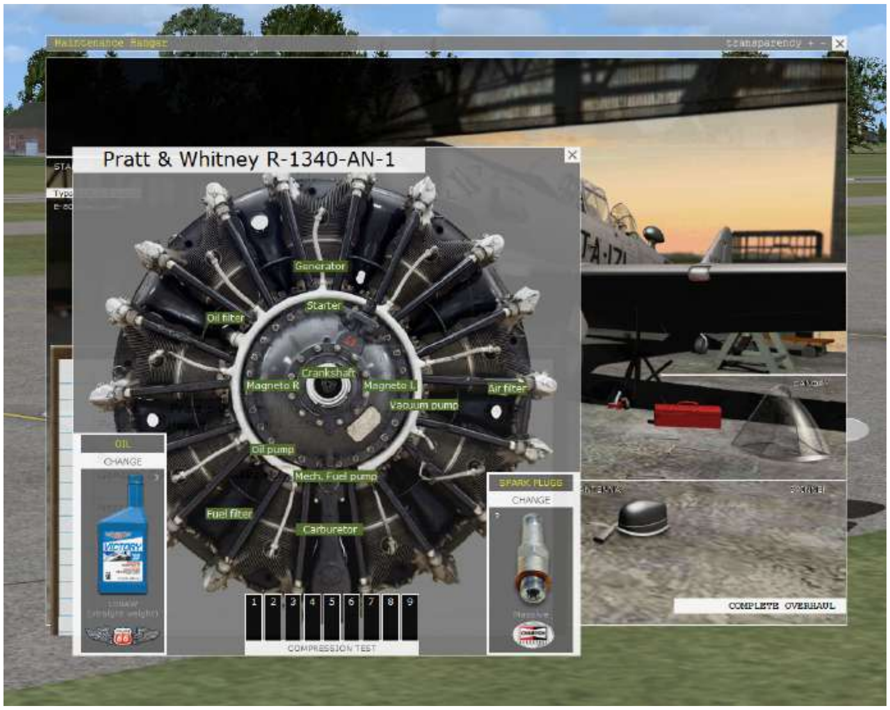
On a standard day (59°F), the air pressure at sea level is 29.92 in. Hg BAROMETRIC PRESSURE. To keep things simple, let's say 30 in. Hg is standard air pressure. You have just taken off and begin to climb. As you reach higher altitudes, you notice your rate of climb slowly getting lower. This is because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

Why does your manifold pressure decrease as you climb?

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

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

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



gauge's sensor is, and when you are idling, that sensor is reading that very low air pressure in that near vacuum.

As you increase power, you will notice your manifold pressure comes up. This is simply because you have used your throttle to open those throttle plates more, and the engine is able to get the air it wants. If you apply full power on a normal engine, that pressure will ultimately reach about the same pressure as the outside, which really just means the air is now equalized as your engine's intake system is running wide open.

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

So if you turned your engine off, your manifold pressure would rise to the outside pressure. So on a standard day at sea level, your manifold pressure with the engine off will be 30".

IGNITION

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

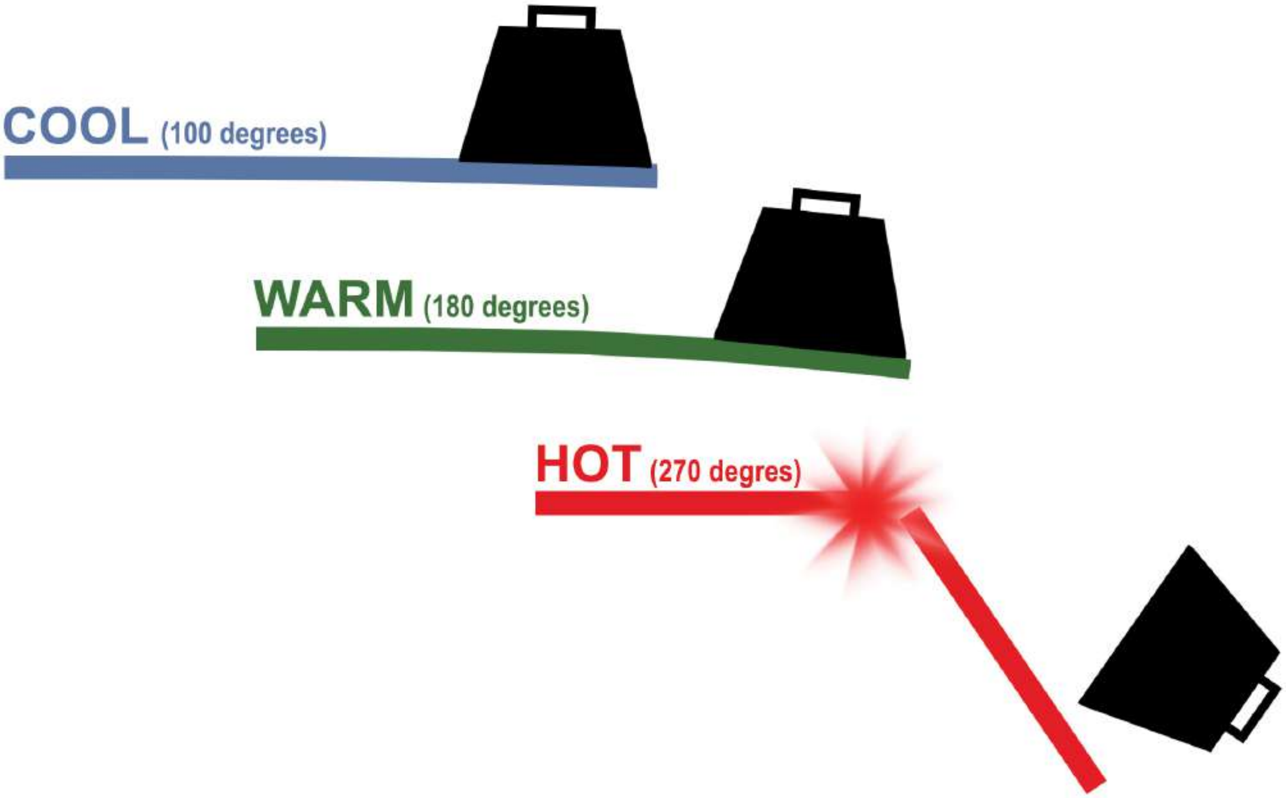
An added advantage to having two sparks instead of one is more sparks means a little more power. The pilot can select Ignition 1, Ignition 2, or BOTH by using the MAG switch. You can test that each ignition is working on the ground by selecting each one and watching your engine RPM. There will be a slight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

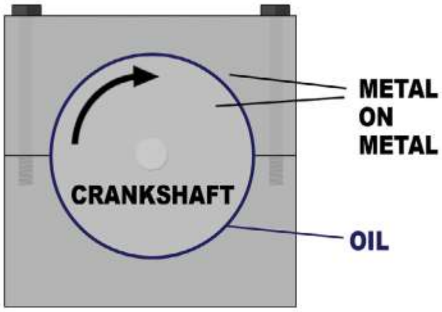
ENGINE TEMPERATURE

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

The hotter the metal, the weaker its strength.

Aircraft engines are made of aluminum alloy, due to its strong but lightweight properties. Aluminum maintains most of its strength up to about 150°C. As the temperature approaches 200°C, the strength starts to drop. An aluminum





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

rod at 0°C is about 5× stronger than the same rod at 250°C, so an engine is most prone to fail when it is running hot. Keep your engine temperatures down to keep a healthy running engine.

LUBRICATION SYSTEM (OIL)

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

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

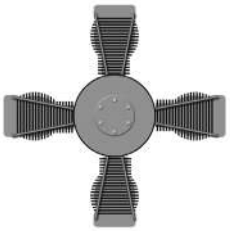
Above is a simple illustration of a crankshaft that is located between two metal caps, bolted together. This is the very crankshaft where all of the engine's power ends up. Vital oil is pressure-injected in between these surfaces when the engine is running. The only time the crankshaft ever physically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

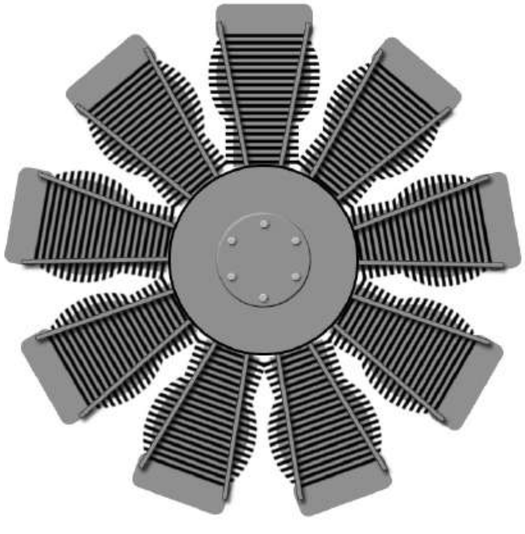
MORE CYLINDERS, MORE POWER

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

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

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





THE PRATT & WHITNEY R4360

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

TORQUE VS HORSEPOWER

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

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

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

PROPELLERS

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

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

THE BERNOULLI THEORY

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

THE NEWTON THEORY

As the air travels across the airfoil's upper and lower surfaces, lift is created by BENDING the air down with great force at its trailing edge, and thus, the Newtonian force of opposite and equal reaction apply.

WHAT WE DO KNOW (AND WHAT THE PILOT NEEDS TO KNOW)

The airfoil is essentially an air diverter and the lift is the reaction to the diverted air. An airfoil's lift is dependent upon its shape, the speed at which it is traveling through the air, and its angle to the oncoming air (angle of attack)."

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

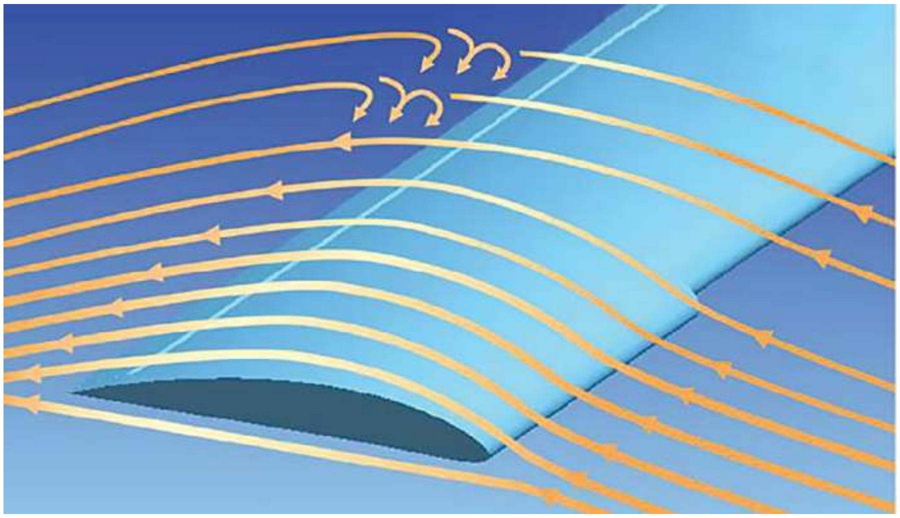
Unfortunately over time, the Bernoulli theory specifically has been misrepresented in many textbooks causing some confusion in the pilot and flight training community. Misrepresentations of Bernoulli such as the "equal transit theory" and other incorrect variations on Bernoulli have caused this confusion.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

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

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

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

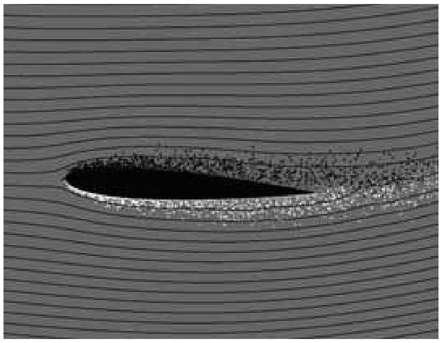
Hopefully we have sparked your interest in the direction of proper research.



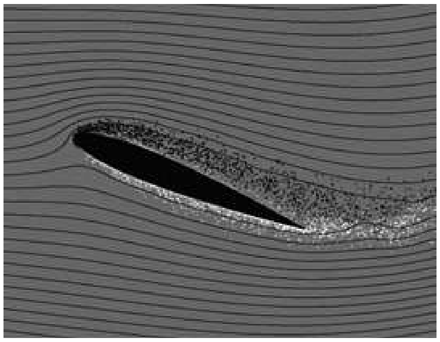
WHAT IS A STALL?

In order for a wing to produce efficient lift, the air must flow completely around the leading (front) edge of the wing, following the contours of the

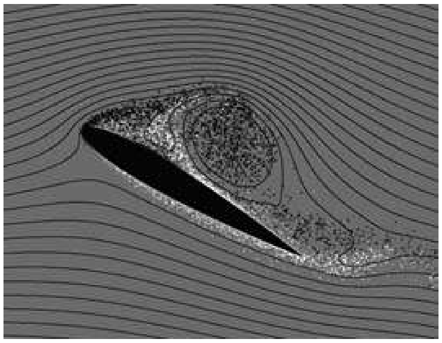
CROSS SECTION OF A PROPELLER BLADE



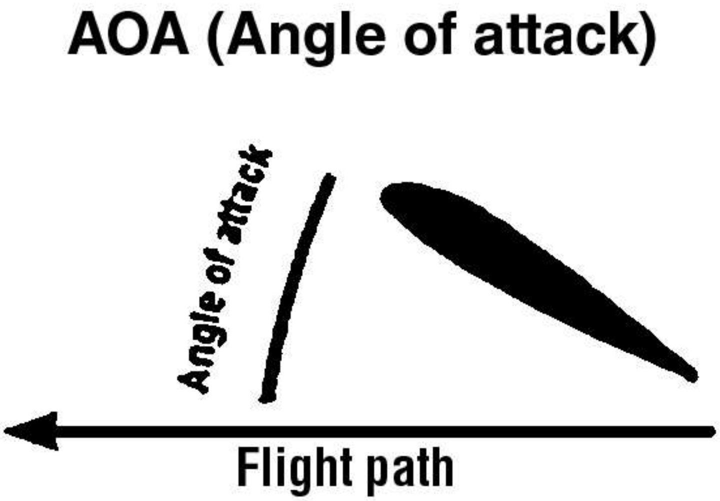
Level Flight. A wing creating moderate lift. Air vortices (lines) stay close to the wing.



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



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



wing. At too large an angle of attack, the air cannot contour the wing. When this happens, the wing is in a "stall."

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

STALL

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

Can a propeller stall?

What do you think? More on this below.

LIFT VS ANGLE OF ATTACK

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

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

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

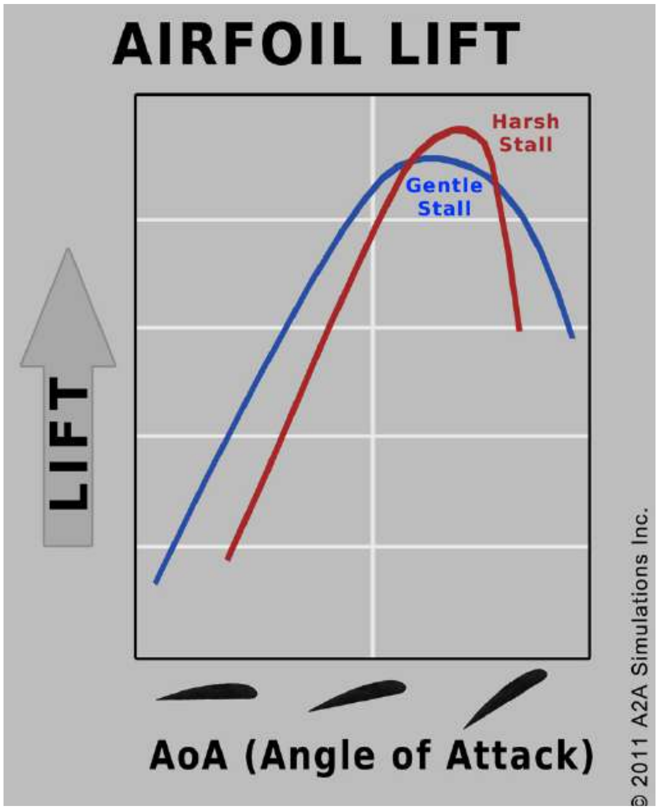
FROM STALL TO FULL POWER

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

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

PROP OVERSPEED

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



THE T-6 TEXAN

AIRPLANE DIMENSIONS.

Approximate over-all dimensions of the airplane are:

Length	29.0 feet
Wing span	42.0 feet
Height	12.0 feet (to top of rudder in level flight attitude)

ENGINE

The airplane is powered by a 600-horsepower (Take-off Power), nine-cylinder Pratt & Whitney radial engine, Model R-1340-AN-1. The engine is equipped with an updraft float-type carburetor and a combination inertia, direct-cranking starter.

ENGINE CONTROLS

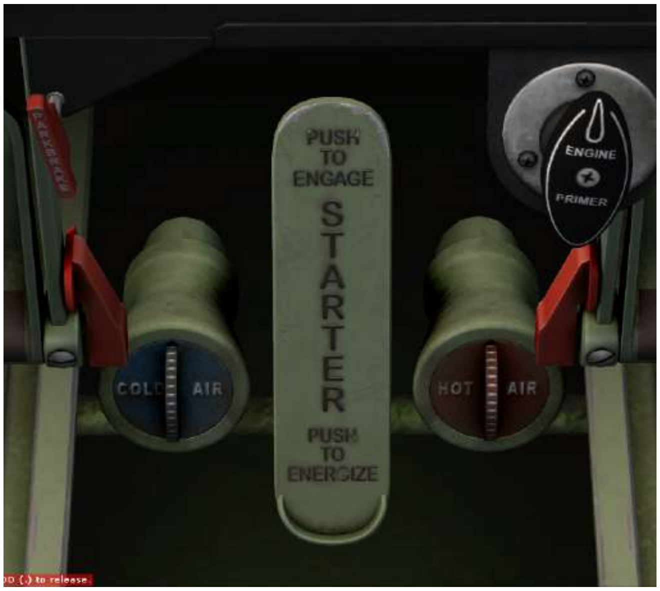
Throttle and mixture controls are located on the throttle quadrant on the left side of each cockpit. A friction lock on the inboard face of the quadrant in the front cockpit only, is rotated to increase friction of the throttle, mixture, and propeller controls. Carburetor mixture temperature is controlled by a carburetor air control in the front cockpit.

THROTTLE

A throttle is located on the quadrant on the left side of each cockpit. A take-off stop is provided in the quadrant so that the pilot can feel when he has reached Takeoff Power at sea level. The throttle in the front cockpit can be pushed through the stop to obtain full throttle travel when additional power is needed at altitudes above sea level. When the throttle is retarded, the landing gear warning horn will sound if the landing gear is not locked in the down position.

MIXTURE CONTROL

The mixture control on the throttle quadrant in each cockpit enables either pilot to control the fuel-air mixture to the engine to obtain efficient engine operation and maximum fuel economy. Positions on the quadrant are RICH (full forward), LEAN (aft), and IDLE CUT OFF (full aft). Any position between RICH and LEAN is in the manual leaning range.



CARBURETOR AIR CONTROL

The carburetor air control handle is located on the left console of the front cockpit. When the control is at COLD, ram air is admitted to the carburetor through the ram air (filtered) inlet on the left side of the engine cowl. As the control is moved toward the HOT position, it gradually closes the ram-air inlet while opening a duct that allows warm air from inside a muff surrounding the exhaust collector ring to mix with the cold ram air before being delivered to the carburetor. When the control is at the full HOT position, the ram-air inlet is fully closed and hot air only is drawn into the carburetor. A carburetor mixture temperature gauge, mounted on the instrument panel in the front and rear cockpits, indicates the temperature of the fuel-air mixture as it enters the engine.

IGNITION SWITCH

A standard ignition switch is located on the left side of the instrument panel in each cockpit. Switch positions are OFF, L, R, and BOTH. The L and R positions are provided to check engine operation on the left or right magneto individually.

STARTER SWITCH PEDAL

Starter switch pedal, located between the rudder pedals in the front cockpit, provides control of the starter. Originally the airplane was delivered with the starter wired to be energized by the heel of the pedal (marked “PUSH TO ENERGIZE”) and engaged (after coming up to speed) by the toe of the pedal (marked “PUSH TO ENGAGE”). However, the starter has been wired for direct cranking, so that pressing either the heel or the toe of the pedal will both energize and engauge the starter to the engine. Power for energizing the starter can be derived from the airplane battery. although an external power source should be connected for this purpose, whenever possible, to conserve battery life.

There are two different starter options in the maintenance hangar, a “Direct” and “Direct Inertia” style starter. The main difference is “Direct” is common on other warbirds in that the starter is directly cranking the engine, whereas in the “Direct Inertia”, the starter cranks an inertia wheel that is then connected to the engine. The later has a very different feel when cranking, in that you can feel the engine and inertia wheel pushing and pulling each other as they both advance together.

ENGINE PRIMER

The engine priming system is controlled by a push-pull hand primer, located below the instrument panel in the front cockpit. The primer pumps fuel from an outlet in the hand fuel pump directly into the five top cylinders to aid in starting. When not in use, the pump should be pushed in and turned to the right to the locked-closed position.

ENGINE INDICATORS

A complete set of engine instruments is mounted in the front and rear cockpits. The oil pressure, fuel pressure, and manifold pressure gauges indicate pressure directly from the engine. When the engine is inoperative, the manifold pressure gauge reading should correspond to barometric pressure. The tachometer and cylinder head temperature gauge readings are self-generated and therefore do not require power from the electrical system of the airplane. Oil temperature and carburetor mixture temperature gauges, however, depend upon the 28 volt system.

MANIFOLD PRESSURE GAUGE DRAINVALVE

A manifold pressure gauge drain valve is provided to clear the manifold pressure instrument lines of moisture and vapors so that accurate indications can be obtained on the gauge. The drain valve is opened by turning a handle, located forward of the front cockpit throttle. The differential between atmospheric pressure and manifold pressure enables flow through the instrument lines to clear them of vapors when the drain valve is opened. The valve should be opened only when the engine is operating below 30 in. Hg manifold pressure so that the vapors will be carried into the engine instead of toward the gauge. Remember that the greatest differential between atmospheric and manifold pressures exists at low power.

PROPELLER

The engine drives a two-bladed, constant-speed, all metal propeller. A propeller control is provided to select the engine rpm to be held constant. A spinner is installed to the propeller hub.

PROPELLER CONTROL

Engine rpm is determined by the setting of a propeller control, located on the throttle quadrant in each cockpit. Positioning of the propeller control mechanically adjusts the setting of a propeller governor mounted on the nose section-of the engine. The propeller governor maintains the selected rpm, regardless of varying air loads or flight attitudes. The propeller control may be placed at any intermediate position between DECREASE and INCREASE rpm, depending upon the engine rpm. To enable maximum rated horsepower to be obtained for take-off, the propeller control is positioned to full INCREASE rpm. During a landing the propeller control is set to obtain 2000 rpm to ensure immediate availability of power in case a go-around becomes necessary.

OIL SYSTEM

Oil for engine lubrication is supplied from a 10.2 gallon tank. Lubrication is accomplished by a pressure system with a dry sump and scavenge pump return. Oil flows from the tank to the engine pressure pump, which forces it through the engine, and is pumped back to the tank by the scavenge pump either directly or through the oil cooler, depending upon the temperature of the oil. A thermostatic valve in the oil cooler regulates the oil temperature by automatically controlling the flow of oil through the cooler. A surge valve is also provided in the by-pass line to enable oil to by-pass the cooler and prevent flow stoppage in case the oil congeals in the cooler.

FUEL SYSTEM

The fuel system incorporates two all-metal fuel cells, which are located in the center section of the wing, and one bladder-type cell, installed in each outer wing panel. Each tank sump is constructed so as to trap fuel around the tank outlets during inverted flight maneuvers. An engine-driven fuel pump supplies fuel under pressure to the carburetor. If the engine-driven pump fails, sufficient fuel pressure can be supplied to the carburetor by means of a hand fuel pump to permit full-power engine operation. Fuel flow by gravity is available only to the fuel selector valve and hand fuel pump.

FUEL QUANTITY GAUGES

A float-type fuel quantity gauge is located on each side of the pilot's seat in the front cockpit. The gauges are visible from the rear cockpit seat, with approximately a 5 gallon increase because of parallax error. The fuel gauges are not sufficiently accurate for exact readings; therefore, the values should be regarded as approximate.

1. Airspeed Indicator
2. Attitude Indicator
3. Altimeter
4. Manifold Pressure
5. Magnetic Compass
6. G-Meter
7. Suction
8. Turn & Slip
9. Heading Indicator
10. Vertical Speed Indicator
11. Tachometer
12. Marker Beacon Indicator
13. Carburetor Mixture Temperature
14. Air Source
15. Ignition Switch
16. Clock
17. VOR 1 Indicator
18. Remote Compass
19. Cylinder Head Temperature
20. Oil Temp/Oil Pressure/ Fuel Pressure
21. Ammeter
22. Hydraulic Pressure
23. Landing Lights
24. Gear Locked Indicator
25. Flap Position Indicator
26. Landing Gear Indicator
27. Smoke Oil Quantity
28. GPS
29. Radio System
30. NAV/GPS Mode Switch
31. Parking Break
32. Primer
33. Starter Pedal
34. Cabin Vent
35. Cabin Heater

FUEL PRESSURE GAUGE

Fuel pressure is indicated on the engine gauge unit. The fuel pressure gauge is the direct-reading type and indicates fuel pressure in the carburetor.

FUEL SELECTORS

Interconnected fuel selector handles are located on the left console of each cockpit, Each selector handle position has a detent to provide a distinct stop. When the

selector is at either LEFT or RIGHT, all the fuel in the respective tank will be consumed. The OFF position shuts off all fuel flow.

A hand fuel pump, operated by interconnected handles, one in each cockpit, is provided to maintain fuel pressure if the engine-driven fuel pump fails.

LOW FUEL QUANTITY WARNING LIGHTS

The low fuel quantity warning lights one each for left and right tank, are located on the left and right sides of each instrument panel. The lights illuminate when the fuel quantity in the respective tank drops to approximately 10 to 12 gallons. The lights can be checked by manually depressing (push-to-test) the desired light.

> **NOTE:** Although this warning system informs the pilot that only 10 to 12 gallons of fuel remains in the related tank, during banking maneuvers it is possible, because of tank baffle and flapper valve design, to "stuff'' fuel into the cell enclosure from which fuel quantity warning is determined. Therefore, when the light illuminates, 6 to 8 gallons of fuel is the maximum that should be relied upon in the related tank.

ELECTRICAL POWER SUPPLY SYSTEM

Electrical power is supplied by a 50-ampere engine driven generator through a 28-volt direct current system.

A 24-volt battery serves as a stand-by power source for use when the generator is inoperative or not supplying sufficient voltage. A reverse-current relay is incorporated to automatically control the generator. The generator "cuts in" at approximately 1250 rpm and "cuts out" when engine speed is reduced to approximately 1000 rpm. Full rated output of the generator is developed above 1650 rpm. A cutout switch isolates the battery from the electrical system during inverted flight.

Two inverters change direct current to alternating current to power the radio compass and remote-indicating compass.

CIRCUIT BREAKERS

All DC circuits, including those for communication equipment, are protected from overloads by push-to-reset circuit breakers. The circuit breakers are located in the front cockpit on the right console.

EXTERNAL POWER RECEPTACLE

An external power receptacle is located on the left side of the fuselage below the rear entrance step. Whenever available, external power should be used for engine starting or electrical ground checks to conserve battery power for use during in-flight emergencies.

BATTERY SWITCH

A battery switch is located in the front cockpit on the right console. All electrical equipment is inoperative when the switch is OFF unless the generator is operating or an external power supply is connected to the airplane. The battery will supply current to all electrical equipment when the battery switch is ON and no other power source is being used. The switch should be OFF when the engine is not running to prevent unnecessary discharge of the battery.

GENERATOR MAIN LINE SWITCH

A generator main line switch, located in the front cockpit on the right console, provides a means of turning off the generator circuit in case the reverse-current relay fails to operate. A guard covers the generator switch and, when down, holds the switch in the ON position. The switch should be left ON at all times except in an emergency.

AMMETER

An ammeter mounted on the instrument panel in each cockpit indicates the amount of current being delivered by the generator.

HYDRAULIC POWER SUPPLY SYSTEM

The hydraulic system is utilized to operate the landing gear and flaps. An engine-driven pump supplies hydraulic pressure for operation of these units.

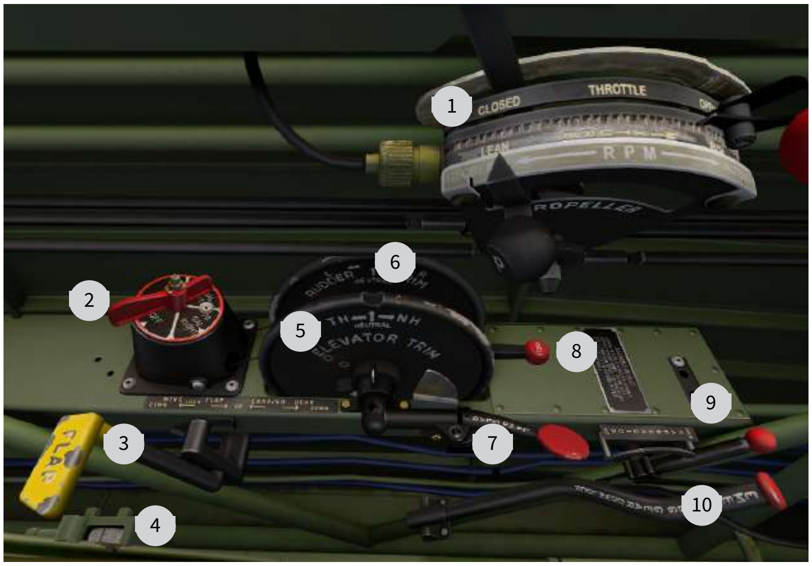
TRIM TAB CONTROLS

Rudder and elevator trim tab control wheels are located on the left console of each cockpit. Trim tab position may be determined from a pointer at each control wheel.

CONTROL LOCK HANDLE (AILERONS, RUDDER,AND ELEVATOR)

All surface controls are locked by means of a control lock handle, located forward of the control stick in the front cockpit.

1. Hobbs Meter
2. Cockpit Lights
3. Fuel Gauge Lights
4. Strobe Light
5. Pitot Heat
6. Nav Light
7. Nav Light Brightness
8. Passing Lights
9. Smoke Arm
10. Avionics Master
11. Battery
12. Generator
13. Breakers



1. Throttle/Mixture/Propeller
2. Fuel Tank Selector
3. Landing Flaps
4. Fuel Gauge
5. Elevator Trim
6. Rudder Trim
7. Landing Gear Lever
8. Manual Fuel Pump
9. Carburetor Heat Lever
10. Landing Gear Lever Emergency Lock

WING FLAPS

Hydraulically operated, split-type wing flaps extend from aileron to aileron. The flaps, operable from either cockpit, travel 45 degrees to the full down position.

No emergency means are provided for raising or lowering the flaps.

WINGFLAP HANDLE

The wing flaps are operated by means of a control handle.

FLIGHT CONTROLS

The primary flight control .surfaces (ailerons, rudder, and elevator) may be operated from either cockpit by conventional stick and rudder pedal controls. Rudder pedals, which are also used to apply the brake and for tail wheel steering, are adjustable fore and aft. Trim tabs on the elevator and rudder are mechanically operated from either cockpit. Aileron trim tabs are adjustable on the ground only. The rudder pedals and control stick can be locked by a mechanical lock in the front cockpit.

CONTROL STICK

The control sticks in both cockpits incorporate a gun-type handle for positive gripping. The rear cockpit control stick, which can be stowed in a bracket at the left side of the cockpit, is removed by actuating a release knob at the lower rear side of the stick. In addition to controlling the ailerons and elevators, the control stick also unlocks the tail wheel (to free-swivel) when placed full forward.

FLAPS DOWN, AND LOCK

The LOCK position is used only to lock the flaps in an intermediate position. The flaps are held in the respective up, down, or intermediate positions by trapped fluid in the lines.

WING FLAP POSITION INDICATOR

The mechanical wing flap position indicator is located on the instrument sub panel. The indicator is marked to visually show the position of the flaps at all times.

LANDING GEAR SYSTEM

The retractable main landing gear is hydraulically operated, and mechanical locks hold the gear in both the down and up positions. The locks are mechanically released by initial movement of the landing gear handle. In case of hydraulic failure, the gear can be unlocked by the landing gear handle and will extend by its own weight. The down locks will then in snap in place. An emergency landing gear down lock handle is provided to mechanically engage the down lock pins in an emergency. A plastic window on each wing, above the respective strut, makes possible a visual check of the down lock pin engagement. The tail wheel does not retract.

LANDING GEAR HANDLE

The landing gear handle is mounted on the left console of each cockpit. The gear handle is shaped in the form of a wheel to facilitate recognition by feel and preclude the necessity of looking for the control. Moving the front cockpit handle to either UP or DOWN mechanically positions the gear up locks or down locks, actuates the power control valve to pressurize the system, and actuates the gear selector valve to raise or lower the gear. There is no neutral position, so the handle must remain in the selected position. The landing gear handle in the rear cockpit also has an UP and a DOWN position, but will only extend the gear. Although the rear handle can be raised, it will not cause the gear to retract, because the front handle is engaged in a detent when at DOWN.

Do not operate the front cockpit landing gear handle when the airplane is on the ground, as there is no safety provision to prevent retraction of the gear.

EMERGENCY LANDING GEAR DOWNLOCK HANDLE

The emergency landing gear down lock handle is located on the left side of the pilot's seat in the front cockpit. The handle is pulled back to manually force the down lock pins into place if the pins fail to automatically lock the gear down. However, the handle must never be actuated until the gear is completely down; otherwise, the down lock pins, while manually forced into place, may not allow the gear to extend fully. After the handle is pulled back, a spring returns it to the normal forward position however, the down lock pins remain engaged.

LANDING GEAR POSITION INDICATOR

A mechanical landing gear position indicator is located on the instrument sub panel in the front cockpit. The indicator shows the approximate position of each gear at all times.

LANDING GEAR DOWNLOCK INDICATOR LIGHTS

The front cockpit landing gear down lock indicator lights, are located on the instrument sub panel. The rear cockpit landing gear indicator lights are located on a panel just below and to the left of the instrument panel. The lights (one for each gear) will illuminate when the gear is down and locked. In addition, down lock indicator lights are installed on the leading edge of each wing near the wheel well. Although these external indicator lights (one for each gear) are not visible to the pilot, they enable ground-observer verification of gear position as a safety feature for night flight training. The external down lock indicator lights illuminate when the gear is down and locked and the navigation lights are on.

LANDING GEAR WARNING HORN

A warning horn is located behind and to the left of the front cockpit seat. If the landing gear is not locked in the DOWN position, the horn will blow when the throttle is retarded beyond a certain point.

STEERING SYSTEM

The non retractable tail wheel can be steered or allowed to free-swivel, as determined by the position of the control stick. With the control stick in any position except full forward, the tail wheel can be steered by the rudder pedals up to a maximum of 15 degrees either side of center. Moving the control stick to the full forward position allows the tail wheel to free-swivel, and the airplane must be steered by the brakes.

BRAKE SYSTEM

Hydraulic brakes on the main wheels are operated by application of toe pressure on the rudder pedals. No emergency method of applying the brakes is provided. The brake system incorporates a master brake cylinder, which is supplied with fluid from the hydraulic system reservoir. A parking brake handle is installed in the front cockpit. Parking brakes are set by depressing the toe brakes, pulling the parking brake handle out, and then releasing the toe brakes. The parking brakes are released by depressing the toe brakes in either cockpit.

INSTRUMENTS

A complete set of engine and flight instrument is installed in each cockpit, with the exception of the hydraulic pressure gauge, which is installed only in the front cockpit. A suction gauge is provided in each cockpit. The gyro horizon, directional gyro, and turn-and-bank indicator are operated by the engine-driven vacuum system. The airspeed indicator is operated by the pitot and static systems, and the altimeter, and rate-of-climb indicator are operated by the static system. The airspeed indicator measures the difference between impact air pressure entering the pitot tube, mounted on the right wing, and static air pressure obtained at vent ports on each side of the rear fuselage. The altimeter and rate-of-climb indicator are connected to the static pores only.

To keep the pitot tube opening clean, a cover is placed over the pitot head whenever the airplane is parked. An accelerometer is installed on the instrument panel in each cockpit. A free air temperature gauge is installed on the instrument panel in each cockpit.

CANOPY

The canopy has two sliding sections, one over each cockpit, which are controlled separately by handles on the exterior and interior. The front sliding section can be locked at four positions: open, closed, and two intermediate positions. The rear sliding section can be locked at three positions: open, closed, and an intermediate position. Both side panels on each sliding section can be forcibly pushed out free from the canopy to provide an emergency exit from the airplane.

AUXILIARY EQUIPMENT

HEATING SYSTEM

Ram air from a duct opening on the top front of the engine is heated in a shroud around the exhaust manifold and is then introduced into the front cockpit. The cockpit hot-air temperature control valve is located inboard of the right rudder pedal. A butterfly valve in the outlet can be rotated by the pilot's foot to regulate the volume of hot air entering the cockpit.

VENTILATING SYSTEM

Cold air for ventilating is obtained from an opening in the leading edge of the left wing center section and is discharged in the front cockpit from a cold-air temperature control valve located inboard of the left rudder pedal. The outlet, which incorporates a butterfly valve, can be adjusted by the pilot's foot to control the volume of air entering the cockpit. A ventilator on the left side of the rear cockpit can be manually opened by a handle to provide fresh air for the rear cockpit. Additional ventilation may be obtained by opening the sliding sections of the canopy to any one of the intermediate positions.

PITOT HEATER

A heater in the pitot head is controlled by the pitot heater switch located on the right-hand console in the front cockpit only.

> **CAUTION:** To prevent burning out heater elements, the pitot heater switch should be OFF when the airplane is on the ground.

EXTERIOR LIGHTS

All exterior lights (landing, navigation, cowl, and passing) are controlled from the front cockpit only.

Landing Light Switches

Landing lights, installed in the leading edge of each wing outer panel, are individually turned ON and OFF by switches located on the instrument subpanel in the front cockpit.

Navigation Light Switch

Navigation lights, located on the wing tips and tail, are controlled by a switch located on the right console in the front cockpit. On most airplanes, the response of the navigation lights corresponds to the switch Positions (FLASH or STEADY), However, on early airplanes, the lights flash only (switch ON). Power to the landing gear downlock indicator lights is provided through the navigation light switch. The left wing lights are red, the right wing lights are green, and the taillights are white and amber. Brilliancy of the lights is controlled by a navigation and cowl light brilliancy switch.

Cowl Light Switch

A white cowl light, located under the engine section, has been disabled on most T-6's flying today, and therefore it is disabled on the A2A T-6 as well.

Navigation And Cowl Light Brilliancy Switch

Brilliancy of the navigation and cowl lights is controlled by a switch on the right console in the front cockpit. The switch has two positions, BRIGHT and DIM.

Passing Light Switch

A red passing light, installed in the leading edge of the left wing beside the landing light, is turned ON and OFF by a switch located on the right console in the front cockpit.

INTERIOR LIGHT CONTROLS

NOTE: Due to limitations in the host program, some of the lights intensities are not adjustable.

Cockpit Light Rheostat

A cockpit light is located on each side of each cockpit to illuminate the respective consoles. Light illumination and brilliance controlled by a rheostat, located on the right console in each cockpit.

Fuel Quantity Gage Light Rheostat And Switch

Lights above each fuel quantity gage can be turned ON or OFF from either cockpit. The fuel quantity gage light is controlled from the front cockpit by a rheostat on the right console and from the rear cockpit by a spring-loaded switch on the right console. Light brilliancy can be controlled by the front cockpit rheostat only. The rear cockpit switch permits full brightness only, regardless of the position of the front cockpit rheostat.

MISCELLANEOUS EQUIPMENT

Map And Data And Flight Report Cases

A map and data case is provided on the right side of the front cockpit and a data case is provided in the rear fuselage. A flight report case is located in the front cockpit on the left, rear side of the pilot's seat.

Armrest

An armrest is provided on the left side of the front cockpit. The armrest is conveniently used when manipulating individual quadrant controls.

AUTOMATIC FLIGHT SYSTEM

The automatic flight system in the A2A's T6 consists of Trutrak Digitrak and Altrak autopilots. These are small, inexpensive units that rely on modern electronics and solid state gyros, instead of mechanical gyroscopes used by traditional autopilots. Because of that, their operation differs from what most Flight Simulator users are accustomed to. We strongly advise to read the original manuals provided in the references section.

STARTUP:

- Avionics switch on the right console must be ON.
- Autopilot switch on the right console must be ON.
- Wait 10 seconds for the autopilots initialization.
- For full functionality, GPS must be installed and ON.

NOTE: the autopilot installation in the aircraft is optional. It can be toggled using Shift+3 menu.

TRUTRAK DIGITRAK

Digitrak autopilot uses signals from internal gyro, GPS and magnetic backup sensor to control the ailerons with electric servo. The autopilot is not connected to any of the flight instruments visible in the cockpit and their malfunction does not affect the autopilot's operation.

FEATURES:

- Maintain selected ground track.
- Maintain constant rate turn.
- Follow GPS flight plan.
- Backup magnetic heading mode if GPS signal is not present.

OPERATION:

- To turn on the autopilot press the ON/OFF button or press the Control Stick Button for min. 1 sec. The autopilot will maintain the current ground track provided by GPS. Selected ground track will be displayed on the autopilot display and can be changed using the arrow buttons. Press the ON/OFF button again to disengage autopilot.
- To initiate a constant-rate turn, press and hold one of the arrow buttons for 1 second. Press the arrow button again to stop the turn. The autopilot will follow the new track.
- You can use the Control Stick button to disengage autopilot completely or temporarily. Press and release the control stick button within one second to disengage the autopilot. Press and hold control stick button to manually steer the aircraft to the new direction. After you release the button, the normal autopilot operation will resume. Altitude hold (if engaged) will remain on during the turn. TIP: use the Input Configurator tool to map the Control Stick button to your joystick or keyboard shortcut.
- If a GPS flight plan is available, then -F- indication will flash periodically on the autopilot's screen. Note: in the flight simulator this is visible only if the Flight Plan is loaded in the flight planner. 3rd party GPS gauges don't provide information about flight plan to our software, so GPS flight following can be activated even if there is no active flight plan in the GPS.
- To start following a GPS flight plan, both arrow buttons need to be pressed simultaneously. This can be accomplished in the Virtual cockpit by clicking either of the buttons using Right Mouse Button.
- If no GPS signal is present, the autopilot will use the backup magnetic sensor to maintain some of the functions. In this situation the autopilot will follow magnetic heading instead of ground track. The magnetic readout is not as accurate as GPS data.There is no VOR/ILS track function in the autopilot.
- The autopilot does not control rudder operation. For coordinated turns, manual rudder input is required.

TRUTRAK ALTRAK

The Altrak autopilot can maintain the current barometric altitude using electrical servo connected to the elevator. It uses its own pitch sensing gyro and pressure sensor, so it's not affected by the attitude indicator or altimeter setting in the cockpit.

The autopilot has only one button that acts also as an indicator. To activate altitude hold, press the button. To disengage altitude hold, press the button again. The altitude hold can be activated only if the Digitrak autopilot is engaged. There is no other mode of operation (like vertical speed or glideslope intercept).

The autopilot doesn't know it the aircraft is flying straight or in a bank, so it may not hold the altitude precisely during turns.

Only the elevator is controlled by the autopilot. The trim is under pilot's control all the time. If the aircraft is not properly trimmed for level flight, the elevator autopilot servo will not be able to overpower the aerodynamic forces on the elevator and the autopilot will not hold the altitude. This condition is signaled by flashing of the autopilot light. Rapid flashing indicates the need to trim UP, while slow flashing indicates the need to trim DOWN.

REFERENCES:

Digitrak User Guide:
http://www.trutrakap.com/wp-content/uploads/2014/03/DigitrakInstallandUserGuide1.pdf

Digitrak Reference Card:
http://trutrakap.com/wp-content/uploads/2014/03/Digitrakref.pdf

Altrak Manual:
http://www.trutrakap.com/wp-content/uploads/2014/03/AltrakVSInstallandUserGuide.pdf

CHECKLISTS

PREFLIGHT CHECKLIST

1. Check takeoff and landing gross weight and balance
2. Make sure that you have sufficient fuel and oil
3. Make sure the weight and balance form is satisfactory
4. Fasten safety belts and shoulder harness. Check manual operation of shoulder harness lock.
5. Adjust seat and rudder pedals
6. Set parking brake and adjust headset
7. Check fuel quantity gauges. Fuel selector 70 GAL LEFT.

NOTE: Steps for starting engine and subsequent ground operation include checking all positions of the fuel selector.

8. Wing flap handle UP. Check flap position indicator.
9. Landing gear handle DOWN. Check gear position indicator.
10. Temporarily place navigation light and battery switches on to check landing gear down lock indicator lights.
11. Check emergency landing gear down lock handle full forward.
12. Carburetor air control COLD.
13. Radio compass switch OFF.
14. Manifold pressure drain valve handle CLOSED.
15. Check generator switch ON.
16. Check gyro switch ON.
17. Check all remaining switches at OFF.
18. Circuit breakers in.
19. Altimeter, accelerometer, and clock set.
20. Gyros UNCAGED.
    The gyro instruments should be uncaged at all times except during maneuvers that exceed operating limits. If gyro horizon bar is not level after engine is started, cage and uncage the gyro 5 minutes before take-off.
21. Note manifold pressure reading (field barometric pressure) for subsequent use during engine power check.
22. Communications equipment off and related circuit breakers in.
23. Adjust cockpit air temperature control valves as desired.

INTERIOR CHECK (NIGHT FLIGHTS)

If night flying is anticipated, the following, additional checks should be made:

1. Have external power source connected. To prevent unnecessary discharge of battery, leave battery switch OFF unless external power is not available.
2. With the aid of outside observer, test operation of navigation, passing, landing, and cowl lights. Check that landing gear down lock lights are illuminated.
3. Check operation of cockpit (fluorescent and incandescent), fuel quantity gauge, and compass lights.
4. Push to test and adjust intensity of all indicator and warning lights.
5. Check for reliable flashlight on board.

START THE ENGINE

1. Check that propeller has been pulled through at least two full revolutions (4 blades).
2. Post fire guard and check propeller clear.
3. Throttle open approximately 1/2 inch.
4. Mixture control full RICH.
5. Check propeller control full DECREASE.
   Since engine is normally shut down with propeller at decrease rpm, it must be started with propeller in same position so that full oil pressure will be available for engine lubrication during starting.
6. Unlock primer and operate 3 or 4 strokes to fill primer lines.

NOTE: Operation of primer to fill primer lines will eliminate excessive cranking when starting engine.

7. Call, “Switches on!”
8. Have external power source connected. To prevent unnecessary discharge of battery, leave battery switch OFF unless external power is not available.
9. Call, “Clear?” and wait for assurance from ground crew before actuating starter switch pedal. After the propeller turns over about two revolutions (4 blades), turn ignition switch to BOTH.
10. Operate primer with slow, even strokes until the engine starts firing. If necessary, continue priming until engine runs smoothly. Lock primer. Do not prime a hot engine.

NOTE: Do not use the fuel hand pump when starting engine as fire may occur if the engine backfires

11. As the engine starts, release starter switch pedal.

NOTE: Should a backfire result, retard the throttle slightly. Do not pump the throttle.

12. Adjust throttle to obtain 500 to 600 rpm as quickly as possible.
13. Check oil pressure; if gauge does not indicate 40 psi within 30 seconds, stop the engine and investigate.
14. Have external power supply disconnected and turn battery switch ON.
15. Check operation of pitot heater with aid of ground crew.

WARM-UP. PROCEDURE.

1. As soon as oil pressure indicates 40 psi, propeller control full INCREASE.
2. Throttle adjusted to obtain the smoothest rpm between 1200 to 1400 rpm for warm-up.
3. VHF radio turned to proper channel.
4. Fuel selector 70 GAL RIGHT,
5. Check generator cut-in at approximately 1250 rpm and cutout at approximately 1000 rpm.

GROUND TESTS

HYDRAULIC SYSTEM-CHECK

Lower flaps and check hydraulic pressure gauge for normal pressure. Raise flaps in increments to check LOCK position. (Flaps should not creep when wing flap handle is in this position.)

With manifold pressure below 30 in. Hg, open manifold pressure gauge drain valve for 3 seconds.

CARBURETOR AIR CONTROL-CHECK OPERATION

Note drop in manifold pressure with increase in mixture temperature.

INSTRUMENTS

Instruments-check for readings in desired ranges.

COMMUNICATIONS EQUIPMENT CHECK

Check proper function of communication equipment.

IGNITION SWITCH-CHECK

Ignition switch-check at 700 rpm, turn ignition switch OFF momentarily. If engine does not cease firing completely, shut down engine and warn personnel to remain clear of the propeller.

CAUTION: Perform this check as rapidly as possible to prevent severe backfire when ignition switch is returned to BOTH.

TAXIING INSTRUCTIONS

Primary controls for taxiing the airplane are the throttle, steerable tail wheel, and brakes. Coordinate these controls for easy taxiing. Observe the following instructions and precautions for taxiing:

1. Have chocks pulled, allow airplane to roll forward slightly, and check the brakes.

   NOTE: Never allow taxi speed to build up before checking the brakes

2. The tail wheel, being steerable by use of the rudder pedals, provides ample control of the airplane under all normal taxiing conditions.
3. To make sharp turns, slow the airplane down, position control stick full forward to disengage tail wheel, and use the brakes to control the airplane. Never allow the inside wheel to stop during a turn. Turning with one wheel stopped may damage the wheel, tire, or strut.
4. The throttle is the main taxi speed control, and most taxiing can be accomplished with it in the closed or slightly open position. Brake usage should be kept to a minimum.

   NOTE: Because of restricted forward visibility, S-turn the airplane well to both sides of the desired track to provide a clear, unrestricted view.

UPWIND TAXIING

The stick should be held fully aft to hold the tail of the airplane on the ground and to ensure positive steering action of the tail wheel.

DOWNWIND TAXIING.

The stick should be held forward to keep the tail from lifting off the ground because of wind pressure being built up beneath the elevators.

NOTE: If the stick is full forward, the tail wheel will free-swivel.

CROSS-WIND TAXIING.

Hold stick into the wind to keep wings level. The primary means of airplane control will be by use of rudder, which is adequate even in extremely strong winds. If necessary, a slight amount of downwind brake may be used but should be held to a minimum.

BEFORE TAKE-OFF.

After taxiing to run-up position, face into the wind and hold brakes; then make the following airplane and engine checks.

PREFLIGHT AIRPLANE CHECK.

1. Primary Controls:
   - Check surface controls for free and proper movement.
2. Instruments and Switches:
   - Altimeter set.
   - Directional gyro set.
   - Gyro horizon set.
   - All instrument readings in desired ranges.
   - All switches at desired positions.
3. Fuel System:
   - Fuel selector on 70 GAL LEFT or 70 GAL RIGHT, whichever contains more fuel.
   - Mixture control full RICH.
   - Primer locked.
4. Flaps:
   - Flaps set for take-off (UP for normal take-off).
5. Trim:
   - Trim tabs set for take-off (elevator-II o'clock, rudder-2 o'clock).

PREFLIGHT ENGINE CHECK.

While performing checks requiring rpm reading, tap the instrument panel to prevent tachometer sticking.

1. Check propeller control at full INCREASE.
2. Propeller check-at 1600 rpm, pull propeller control back to full DECREASE position and at 1400rpm return control to full INCREASE position.
3. Power check-adjust manifold pressure to field barometric pressure (as read on manifold pressure gauge before starting engine) and check for 2000 (+ 50) rpm.

   NOTE: If less than the prescribed rpm is obtainable for given manifold pressure, engine is not developing sufficient power and should be corrected before flight. When running engine up to high power, be careful to have stick back and brakes applied.

4. Ignition system check-with throttle adjusted to 2000 rpm, position ignition switch to L and R and, in each position, check for maximum drop of 100 rpm. The absence of any rpm drop indicates that the opposite magneto is not being electrically grounded during the test as it should be. Between checks, return ignition switch to BOTH to allow speed to stabilize. If drop exceeds 100 rpm, return ignition switch to BOTH and run engine up to Take-off Power for a few seconds to dear spark plugs; then recheck ignition system at 2000 rpm. Return ignition switch to BOTH at completion of test.

   NOTE: During the test, observe the ring cowl for excessive vibration; a faulty ignition wire or one or more bad spark plugs will cause the cowl to vibrate excessively.

5. Cruising fuel-air mixture check-with propeller control at full INCREASE and mixture control full RICH, allow engine speed to stabilize at 1900 rpm. Move mixture control into the manual leaning range until an approximate 100 rpm drop is noted; then return to RICH. The engine speed should increase very slightly before it decreases. An immediate decrease indicates the mixture is set too, lean. A momentary increase in excess of 25 rpm indicates the mixture is set too rich.
6. Idle speed check-with throttle against the idle stop, the engine should idle at 450 rpm.
7. Acceleration and deceleration check-with the mixture control at RICH, advance throttle from idle to 2000 rpm. Engine should accelerate and decelerate smoothly with no tendency to backfire.

   RAPID reversal or sudden throttle movements must be avoided.

8. Carburetor air control full COLD

TAKE-OFF

Plan your take-off according to the following variables affecting take-off technique: gross weight, wind, outside air temperature, altitude of field, type of runway, and height and distance of the nearest obstacles.

NORMAL TAKE-OFF.

In order to perform a takeoff within the distance specified in the Take-off Distances chart the following procedure must be used:

1. Visually check final approach for aircraft, then roll into take-off position and line up airplane with runway.
2. Canopy locked open for improved visibility and to permit immediate escape in case of sudden emergency.
3. Tail wheel engaged for steering.
4. Advance throttle smoothly to Take-off Power.
5. Use elevator control to permit the airplane to assume a tail low attitude for take-off. With proper trim setting for the load condition, the elevator will be in approximately neutral position.
6. Allow the airplane to fly itself off the ground, using only slight back pressure on the control stick.
7. Normal take-off speed is approximately 80 mph.

   NOTE: For procedure to follow if engine fails during take-off, refer to the Emergencies chapter.

MINIMUM-RUN TAKE-OFF

A minimum-run take-off is a maximum performance maneuver with the airplane near stalling speed. It is directly related to slow flying and flaps-down stalls; consequently, you should be familiar with these maneuvers before attempting to make a minimum-run take-off.

CROSS-WIND TAKE-OFF

The following procedure is recommended· for cross¬ wind take-off:

1. Advance throttle to Take-off Power setting and maintain directional control with rudder.
2. Continue as in a normal take-off, applying sufficient aileron into the wind pressure to maintain wing level· attitude, or even enough aileron to effect a slight wing-low-into-the-wind take-off. Care must be taken to compensate for the added effectiveness of the aileron control as airspeed increases.
3. As airspeed increases, compensate for the increase in aileron effectiveness and perform a normal take-off with a slight wing-low-into-the-wind attitude.
4. After becoming airborne, counteract drift by making a coordinated turn into the wind.

NIGHT TAKE-OFF

Night take-off procedure is the same as for daylight operation. However, a thorough knowledge of switch and light location is essential. The following additional checks are recommended for night take-off:

1. Turn cockpit lights low.
2. Tune radio carefully and loud, as it will fade during take-off and flight.
3. Hold airplane steady on a definite reference point during the take-off run.
4. Don’t be alarmed by exhaust flame.

AFTER TAKE-OFF

1. When the airplane is definitely airborne, move landing gear handle to UP. Approximately 15 seconds is required for gear retraction.
2. Reduce engine output to Maximum Continuous Power by first retarding throttle, then propeller control.

   NOTE: For training purposes, reduce power to 30 in. Hg manifold pressure at 2000 rpm.

3. Establish a constant climb attitude.

CLIMB

1. Advance throttle to maintain manifold pressure during climb.

   NOTE: For training purposes, maintain 110 mph, 30 in. Hg manifold pressure, and 2000 rpm.

2. Close canopy upon reaching 3000 feet, and lean mixture for smooth operation.
3. Refer to Normal Power Climb chart for climb data power settings, recommended airspeed, rate of climb, and fuel consumption.

SYSTEMS OPERATION

Information pertaining to use of Take-off Power, manual leaning of carburetor mixture, propeller operation, carburetor icing, detonation, preignition, and fuel system operation is included in Systems chapter. Other special operating techniques may be added to this section as required.

DESCENT

Descending with throttle closed, and gear and flaps up, the airplane can cover long distances with a comparatively small loss of altitude. Lowering either the flaps or landing gear greatly steepens the gliding angle and increases the rate of descent. Before entering a descent, close throttle and move mixture control toward RICH to provide smooth engjne operation at the reduced rpm. Because the engine cools rapidly during a descent with the throttle retarded, clear the engine approximately every 30 seconds by advancing the throttle slowly and smoothly to 25 in. Hg manifold pressure to prevent fouled plugs.

Do not allow cylinder head temperature to drop below 100°C during descent.

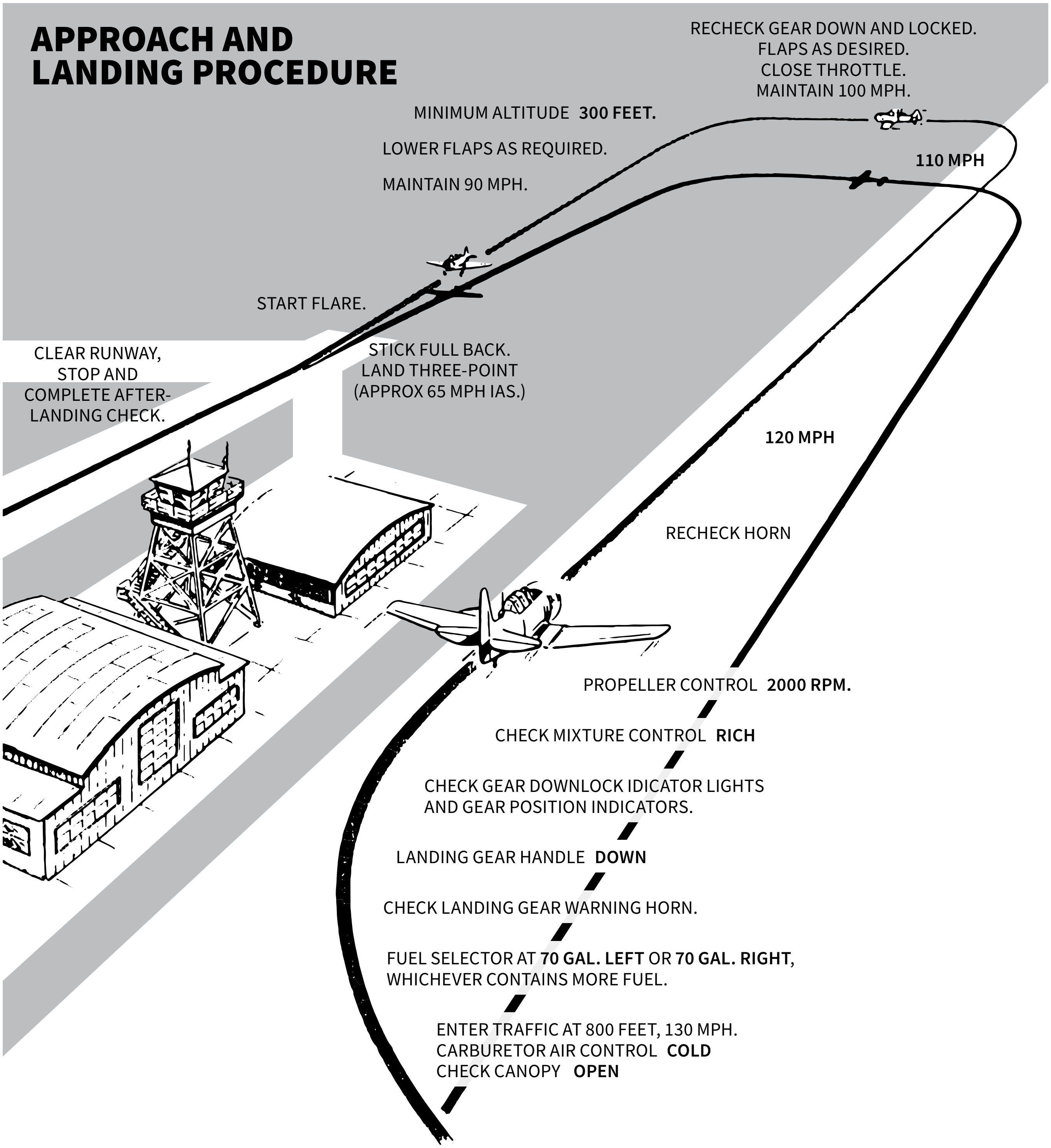
For training purposes, the following should be accomplished.

1. Open canopy as a safety precaution upon reaching 3000 feet.
2. Mixture control full RICH to prevent engine roughness and possible cutout during descent.

TRAFFIC PATTERN CHECK LIST

Traffic pattern procedure and check list are shown in the figure on the facing page.

APPROACH AND LANDING PROCEDURE



RECHECK GEAR DOWN AND LOCKED.
FLAPS AS DESIRED.
CLOSE THROTTLE.
MAINTAIN 100 MPH.

MINIMUM ALTITUDE **300 FEET.**

LOWER FLAPS AS REQUIRED.

MAINTAIN 90 MPH.

110 MPH

START FLARE.

CLEAR RUNWAY,
STOP AND
COMPLETE AFTER-LANDING CHECK.

STICK FULL BACK.
LAND THREE-POINT
(APPROX 65 MPH IAS.)

120 MPH

RECHECK HORN

PROPELLER CONTROL **2000 RPM.**

CHECK MIXTURE CONTROL **RICH**

CHECK GEAR DOWNLOCK IDICATOR LIGHTS
AND GEAR POSITION INDICATORS.

LANDING GEAR HANDLE **DOWN**

CHECK LANDING GEAR WARNING HORN.

FUEL SELECTOR AT **70 GAL. LEFT** OR **70 GAL. RIGHT,**
WHICHEVER CONTAINS MORE FUEL.

ENTER TRAFFIC AT 800 FEET, 130 MPH.
CARBURETOR AIR CONTROL **COLD**
CHECK CANOPY **OPEN**

FINAL APPROACH AND TOUCHDOWN

In order to obtain the results stated in the Landing Distances chart, accomplish the approach and landing procedures outlined. In addition, observe the following precautions and techniques: Just before reaching end of runway, start flare. Use smooth, continuous back pressure on the stick to obtain a tail-low attitude for landing. Change attitude evenly and slowly; don't jerk the control or go down in steps. Note that the attitude for this landing is similar to that attained in a gear and flaps-down stall. Touch down in three-point attitude. The ailerons are only partially effective at low speeds but can still be used advantageously during the round-out and touchdown. Since the vertical stabilizer is offset to the left almost 2 degrees to counter act propeller torque at cruising speeds, a slight amount of left rudder pressure should be applied throughout the round-out and touchdown to prevent swerving to the right when landing in calm wind or straight into the wind. After touchdown, hold the stick back to help keep the tail down for positive tail wheel steering.

LANDING ROLL

Since most landing accidents in this airplane occur during the landing roll, it is during this operation that you must be extremely alert. Immediately on touchdown, the airplane might swerve suddenly or skip on the runway. This sudden swerve is sometimes caused by landing in a slight drift or skid; Use ailerons as necessary to counteract a wing-low condition. Remain alert for a tendency to swerve to the right. When possible, take advantage of runway length to save brakes. Test brakes carefully before their use becomes a necessity, and apply them soon enough to avoid abrupt braking action. Since the rudder, which is the main directional control, will be less effective as you slow down, you must be particularly alert as you near the end of the landing roll.

CROSS-WIND LANDING

Use aileron-into-the-wind, opposite rudder (wing-low) method of landing in a cross wind.

1. Allow for drift while turning on final approach so that you won't overshoot or undershoot the approach leg.
2. Establish drift correction on final approach by lowering the wing into the wind, using opposite rudder to maintain the longitudinal axis parallel with the runway, as soon as drift is detected.
3. Velocity and direction of the wind will determine the amount of flaps used for the landing.

NOTE: Since an airplane acts like a weather vane, "it attempts to swing into the wind. Flaps increase this weather-vaning tendency, so use a minimum degree of flaps in a cross wind.

4. Maintain aileron into the wind with opposite rudder for drift correction throughout the round-out, touchdown, and landing roll, compensating for the loss of effectiveness of the aileron as airspeed decreases by applying additional aileron into the wind. Actual touchdown will be two-point, upwind main gear and tail wheel.

NIGHT LANDING

The same techniques and procedures used for day landings will be applied. Don't turn on the landing lights at too high an altitude and avoid using them at all if landing in fog, smoke, or thick haze, as reflection from the lights impedes vision and may distort depth perception. Alternate the use of landing lights while taxiing after landing.

GO-AROUND

A typical go-around procedure is shown below. Decide early in the approach whether it is necessary to go around, and start before you reach too low an altitude.

AFTER LANDING

After the landing roll, clear the runway immediately and come to a complete stop. Before taxiing to the line:

1. Wing flap handle UP.
2. Trim tab control wheels neutral.
3. Propeller control full INCREASE.

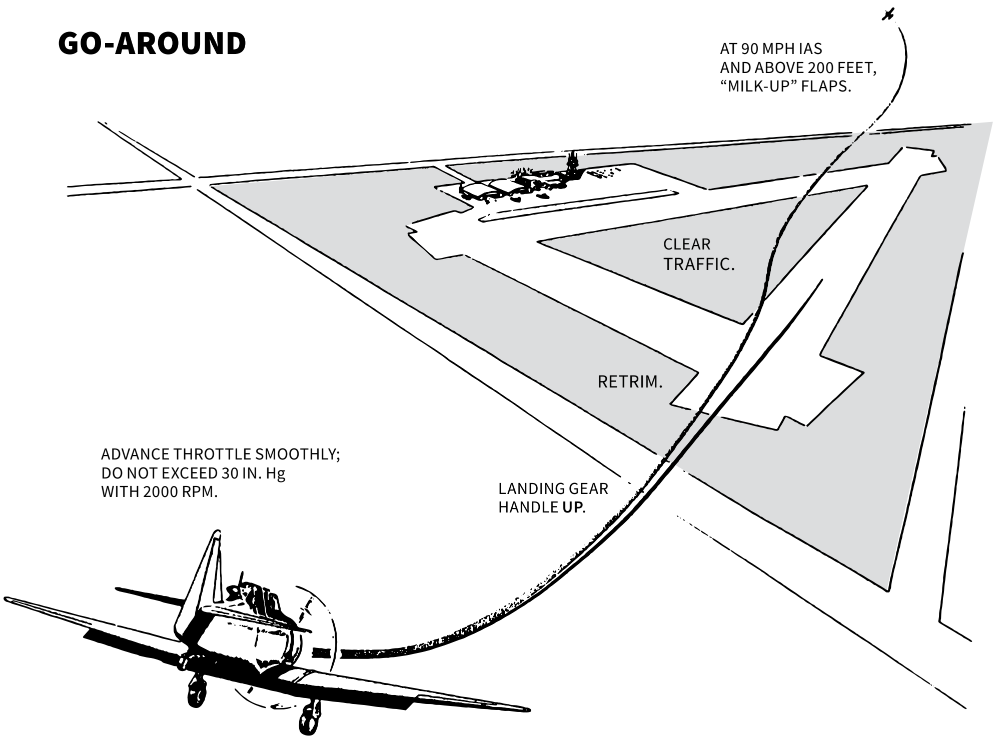
POST FLIGHT ENGINE CHECK

After the last flight of the day, make the following checks:

NOTE: While performing checks requiring rpm reading, it may be necessary to tap the instrument panel to prevent tachometer sticking, especially in cold weather.

1. Check propeller control at full INCREASE.
2. Ignition switch check-at 700 rpm, turn ignition switch OFF momentarily. If engine does not cease firing completely, shut down engine and warn personnel to remain clear of the propeller until the ignition discrepancy has been corrected. Perform this check as rapidly as possible to prevent severe backfire when ignition switch is returned to BOTH.
3. Idle speed and mixture check-with throttle against idle stop, the engine should idle at 450 rpm. When engine speed is stabilized, move the mixture control slowly and smoothly toward IDLE CUT OFF. Carefully observe the manifold pressure gauge for any change during the leaning procedure. The manifold pressure

GO-AROUND



should decrease slightly before it increases. An immediate increase indicates the mixture is set too lean. A momentary decrease in excess of ¼ in. Hg indicates the mixture is set too rich. Return mixture control to RICH before engine cuts out.

4. Power check-adjust manifold pressure to field barometric pressure (as read on altimeter with elevation set to zero) and check for 2000 (±50) rpm.

NOTE: If less than the prescribed rpm is obtainable for given manifold pressure, the engine is not developing sufficient power and should be corrected before the next flight. When running engine up to high power, be careful to have stick back and brakes applied.

5. Ignition system check-with throttle adjusted to 2000 rpm, position ignition switch to L and R, and in each position, check for maximum drop (not to exceed 100 rpm). Return ignition switch to BOTH between checks to allow speed to stabilize. If drop exceeds 100 rpm, return ignition switch to BOTH and run engine up to Take-off Power for a few seconds; then recheck ignition system at 2000 rpm. Return ignition switch to BOTH at completion of test.
6. Cruising fuel-air mixture check-with propeller control at full INCREASE and mixture control full RICH, allow engine speed to stabilize at 1900 rpm. Move mixture control into the manual leaning range until an approximate 100 rpm drop is noted; then return to RICH. The engine speed should increase very slightly before it decreases. An immediate decrease indicates the mixture is set too lean. A momentary increase in excess of 25 rpm indicates the mixture is set too rich.

NOTE: Any discrepancies detected during the post-flight check should be entered on Form 1.

STOPPING ENGINE

When a cold-weather start is anticipated, dilute oil as required by the lowest expected temperature. For oil dilution instructions, refer to the All-Weather Operation chapter.

1. Parking brakes set.
2. Open throttle to approximately 1450 rpm, place propeller control in full DECREASE, and allow engine to run for approximately one minute to allow the oil from the propeller to be scavenged back to the oil tank.
3. Stop engine by pulling mixture control full aft to the IDLE CUT-OFF position.
4. When propeller stops, close throttle completely and turn ignition switch to OFF.
5. Radio off.
6. All electrical switches off.
7. Battery switch OFF. Leave the generator switch ON.
8. Fuel selector OFF.

BEFORE LEAVING AIRPLANE

1. Have the wheels chocked; then release brakes.
2. Lock the surface controls.
3. Complete Form 1.
4. Close canopy.

EMERGENCIES

Engine failures fall into two main categories: those occurring instantly, and those with ample warning before failure. The instant failure is rare and usually occurs only if the ignition or fuel flow completely fails. Most engine failures are gradual and give the alert pilot ample indication that he may expect a failure. An extremely rough-running engine, loss of oil pressure, excessive cylinder head temperature under normal flight conditions, loss of manifold pressure, and fluctuating rpm are indications that a failure is imminent. When indications point to an engine failure, the pilot should make a landing immediately.

PARTIAL ENGINE FAILURE

If engine failure appears imminent, and if altitude permits and it is reasonably safe to attempt to regain normal engine operation, proceed as follows:

1. Fuel selector to 70 GAL RIGHT or 70 GAL LEFT, depending on which tank contains more fuel.
2. If necessary, maintain adequate fuel pressure with hand fuel pump.
3. Mixture control full RICH.
4. Propeller control full INCREASE.
5. Check ignition switch at BOTH.

Carburetor air control HOT if icing conditions exist.

COMPLETE ENGINE FAILURE.

If the engine fails completely and if there is still sufficient altitude and it is reasonably safe to restart the engine, accomplish the foregoing procedure (partial engine failure) and then proceed as follows:

1. Move mixture control to IDLE CUT-OFF.
2. Advance throttle to full OPEN for a few seconds to clear engine.
3. Readjust throttle to 1/2 inch open.
4. Mixture control full RICH.
5. Prime engine if necessary.

If this procedure fails to restart the engine, shut down engine as follows:

1. Mixture control to IDLE CUT-OFF
2. Throttle CLOSED.
3. Ignition switch OFF.
4. Fuel selector OFF.
5. Battery and generator switches OFF except when power is desired to operate lights or communication equipment.

ENGINE FAILURE DURING TAKE-OFF

If the engine fails during the take-off run, immediately close throttle and apply brakes. If remaining runway is insufficient for stopping and it becomes necessary, collapse the landing gear; then, if time permits, move the mixture control to IDLE CUT-OFF. Get clear of airplane immediately.

ENGINE FAILURE AFTER TAKE-OFF

If the engine fails immediately after take-off, proceed as follows:

1. Lower nose immediately to maintain airspeed above stall.
2. Landing gear handle UP. (Even if there is not sufficient time or hydraulic pressure to completely raise gear, it is better to have it unlocked so that it will collapse on landing. Judgement should be used on long runways where a gear-down landing could be accomplished.)
3. Fuel selector OFF.
4. Land straight ahead, changing direction only enough to miss obstacles. Don’t try to turn back to the field. Making a crash landing straight ahead with airplane under control is much better than turning back and taking the chance of an uncontrolled roll into the ground.

ENGINE FAILURE DURING FLIGHT

If the engine fails during flight:

1. Lower nose as speed drops to maintain glide at approximately 100 mph.
2. If altitude permits, attempt to restart engine.
3. If it is impossible to restart engine; make a forced landing if possible; otherwise, bail out.

MAXIMUM GLIDE

Maximum glide distance can be obtained by maintaining a speed of 100 mph with gear and flaps up and with propeller control at full DECREASE rpm to minimize drag.

EMERGENCIES

DEAD-ENGINE LANDING

1. Hold speed of 100mph IAS for maximum glide distance with gear and flaps up
2. Mixture – IDLE CUT OFF
3. Throttle – CLOSED
4. Ignition switch – OFF
5. Fuel selector – OFF
6. Battery and generator switches – OFF

NOTE: Do not turn battery off until just before touchdown if landing lights and radio are needed.

7. Propeller control – FULL DECREASE
8. Canopy locked – OPEN
9. Leave landing gear handle up unless certain that field is suitable for a gear down landing. Remember the airplane will glide further with gear up. If landing gear is lowered, yaw the airplane to lock gear down.
10. Parachute unbuckled.
11. Shoulder harness locked. Remember, some switches are not readily accessible when harness is locked.
12. Steepen glide, lower flaps as required and reduce speed to 75mph IAS

WARNING: Do not slip airplane below 90mph IAS

13. Land as nearly upwind as possible
14. Touchdown approaching stall speed with tail low, whether gear is up or down

PROPELLER FAILURE

A runaway condition of the propeller caused by excess power and decreased load on the engine can occur in a prolonged dive, and the engine may exceed the overspeed limit of 2800 rpm. At first evidence of a runaway or over-speeding propeller:

1. Retard throttle.
2. Adjust propeller control in an attempt to bring propeller within limits.
3. Pull airplane up in a climb to increase load on engine..

ENGINE FIRE DURING FLIGHT

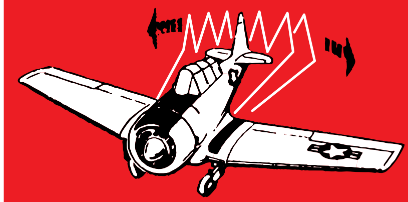
Depending upon the severity of the fire, either bail out immediately or shut down the engine as follows in an attempt to extinguish the fire:

1. Mixture control to IDLE CUT-OFF.
2. Throttle CLOSED.
3. Ignition switch OFF.
4. Fuel selector OFF.
5. Battery and generator switches OFF, except when power is desired to operate lights or communication equipment.

IN CASE OF HYDRAULIC FAILURE, THE LANDING GEAR CAN BE LOWERED AS FOLLOWS:

1 Reduce airspeed below 125 mph IAS so that air loads won't prevent gear from lowering.

2 Landing gear handle down. verify that handle is engaged in detent.



3 Yaw airplane, if necessary, to lock gear.

4 Check landing gear position indicators.

5 Observe engagement of downlock pins through inspection window on each wing.

6 Retard throttle and note silence of warning horn to verify gear down and locked.

LANDING EMERGENCIES: GEAR RETRACTED

If the gear fails to extend, a wheels-up landing can be made on either hard or soft ground as follows:

1. Shoulder harness locked.

   CAUTION: Remember some switches are not readily accessible when the harness is locked.

2. Establish a normal flaps-down approach.
3. Flare out as in a normal landing (with tail low). This will enable tail wheel to absorb the initial shock.
4. Mixture control to IDLE CUT-OFF.
5. Get clear of airplane immediately.

ONE WHEEL RETRACTED (HARD GROUND)

Ordinarily a wheels-up landing is preferable to a landing with only one wheel extended. However, if one wheel is extended and cannot be retracted, proceed as follows:

1. Shoulder Harness locked

   CAUTION: Remember some switches are not readily accessible when the harness is locked.

2. Make normal flaps-down approach with wing low on the extended gear side.
3. Touch down on main wheel and tail wheel simultaneously. Use ailerons to hold up wing with retracted gear.
4. Shut down engine.
5. Maintain controlled ground roll by use of steerable tail wheel and brake.
6. When wing tip strikes the ground, apply maximum brake pressure possible without raising the tail.

DITCHING

The airplane should be ditched only as a last resort. Since all emergency equipment is carried by the pilots, there is no advantage in riding the airplane down. However, if for some reason bail-out is impossible and ditching is unavoidable, proceed as follows:

WARNING: Be sure to ditch while sufficient fuel is available.

1. Follow radio distress procedure.
2. Turn battery switch OFF.
3. See that no personal equipment will foul when you leave the airplane.
4. Unbuckle parachute and release the life raft from the parachute harness. Tighten and lock safety belt and shoulder harness, as there is a violent deceleration of the airplane upon final impact.
5. Check landing gear handle UP.
6. Canopy full open and locked.
7. Lower wing flaps 20 degrees if sufficient hydraulic pressure is available.
8. Make normal approach with power if possible, and flare out to a normal landing attitude. Touch down approaching stalling speed with tail low. Unless the wind is high or the sea is rough, plan the approach heading parallel to any uniform swell pattern and try to touch down along a wave crest or just after a crest has passed. If the wind is as high as 40 mph or the surface is irregular, the best procedure is to approach into the wind and touch down on the falling side of the wave.
9. Just before impact, turn ignition switch OFF.
10. The back cushion of both cockpit seats is filled with kapok and may be used as a life preserver.
11. When leaving airplane, be sure to carry life raft with you.

FUEL SYSTEM EMERGENCY OPERATION

If the engine-driven fuel pump fails, fuel can be supplied to the engine by operation of the hand fuel pump on the left side of each cockpit. If gasoline fumes can be detected by the pilot, a landing should be made as soon as possible and the source of fumes investigated.

ELECTRICAL POWER SYSTEM EMERGENCY OPERATION

If the ammeter shows zero current during flight, it may indicate failure of the generator system. In such case, the battery will supply the electrical load for a short time only. Turn the generator switch OFF, and conserve the battery by using electrical equipment sparingly. If a complete electrical failure occurs or if it becomes necessary to turn off both the generator and battery switches, landing should be made as soon as possible.

LANDING GEAR EMERGENCY LOWERING

The procedure for lowering the landing gear in case of complete hydraulic failure is given in the figure on facing page.

LANDING GEAR EMERGENCY DOWNLOCK

If the landing gear fails to automatically lock in the down position, move the emergency landing gear down¬ lock handle back to the extreme rearward position. This manually forces the downlock pins in place to lock the gear down. However, the handle must never be pulled full back before the gear is completely down; if the handle is pulled back when the gear is partially down, the downlock pins may prevent the gear from extending fully.

NOTE: The landing gear downlock pins can be visually checked for locked position through a window in the wing above the landing gear strut

ALL WEATHER OPERATION

Except for some repetition necessary for emphasis or continuity of thought, this section contains only those procedures that differ from, or are in addition to, the normal operating instructions contained in Section II.

NIGHT FLYING

There are no predominant differences between night flying procedures and day flying procedures. Exhaust glare will obviously be more pronounced during night flights, but should be no cause of alarm. Refer to Section II for night flight interior check, take-off, and landing procedures.

INSTRUMENT FLIGHT PROCEDURES

Stability and rapid acceleration/deceleration are the outstanding instrument flight characteristics of the airplane. All the necessary flight instruments are provided. In an emergency, flight on the basic flight instruments (turn-and-bank indicator and airspeed indicator) can be safely accomplished. Radio compass, range reception, VHF transmission, and VHF reception are all provided in addition to interphone communication between cockpits. Remember, since power settings are somewhat higher during certain phases of instrument flight, the airplane range will be slightly decreased.

NOTE: All turns are single-needle-width standard rate (3° per sec.) turns.

PRIOR TO TAKE-OFF

1. Check G file for inclusion of AN 08-15-1 (Radio Facilities Charts), AN 08-15-2 (USAF Radio Data and Flight Information), and Pilot's Handbooks - Continental United States.
2. Check suction gage for proper indication.
3. Check that the pitot head cover has been removed. Turn pitot heater on and have outside observer verify its operation. Turn pitot heater off until just before take-off.
4. Check airspeed indicator needle at zero. Check airspeed correction card for any deviation at the speed range to be flown.
5. If the directional gyro has been actuated for at least 5 minutes, the rotor will have attained proper operating speed. The ·dial card should revolve with the knob when the gyro is caged but not when the gyro is uncaged. Set the directional gyro so that it corresponds to the reading of the magnetic compass.
6. If the gyro horizon has been actuated for at least 5 minutes, the rotor will have attained proper operating speed. Cage the instrument and then uncage it. After the instrument is uncaged, the horizon bar should return to the correct position for the attitude of the airplane. Temporary vibration of the horizon bar is permissible.

   NOTE: If the horizon bar temporarily departs from horizontal position while the airplane is being taxied straight ahead, or if the bar tips more than 5 degrees during taxiing turns, the instrument is not operating properly.

7. Obtain station altimeter setting (sea level barometric pressure) from control tower operator. When altimeter is set, the pointers should indicate local field elevation. If the altimeter registers within 75 feet, it may be used, provided the error is properly considered when the instrument is reset during flight.
8. Check operation of turn-and-bank indicator by observing proper response of needle and ball when turns are made during taxiing.
9. Check rate-of-climb indicator needle at zero.

   NOTE: If the needle does not indicate zero, tap the instrument panel. If it still indicates incorrectly, readjust it by use of the screw in the lower left corner of the instrument.

10. Check accuracy of the magnetic compass by comparing its reading to the published runway heading.
11. Check that clock is operating and is set to correct time.
12. Move carburetor heat control handle to HOT. Proper operation is verified by a resultant drop in manifold pressure as the mixture temperature increases. Return carburetor heat control handle to COLD.
13. Check instruments for readings within proper ranges.
14. Check operation of all radio equipment. Adjust tuning of required radio equipment as desired.

INSTRUMENT TAKE-OFF

Preparation, power settings, and take-off and climb speeds are identical to those used in normal take-off.

Since use of flaps reduces rate of climb, flaps should not be used for instrument take-offs.

1. When cleared for take-off, taxi to the center of the runway and align the airplane, as nearly as possible, straight down the centerline of the runway. Hold the airplane with the brakes. Set directional gyro to the published runway heading.
2. When ready, advance throttle to obtain 1000 to 1200 rpm. Release brakes and, as the airplane starts to roll, advance throttle smoothly to the sea-level stop.
3. Maintain directional control by reference to directional gyro. When elevator control becomes effective, raise the tail slightly and allow the airplane to leave the ground with the nose slightly lower than a three-point attitude as indicated on the gyro horizon.

   Prior to take-off under instrument conditions,· special attention should be given to gyro instruments and airplane trim. Any irregularity could have serious consequences.
4. Hold this pitch attitude and, as the airplane breaks ground, hold the wings level by reference to the gyro horizon. Hold direction by reference to the directional gyro.
5. As soon as the altimeter and rate-of-climb indicator begin to register a climb, retract the landing gear.
6. Reduce the throttle and propeller control setting to give approximately 30 in. Hg manifold pressure and 2000 rpm only after climbing airspeed is reached.

INSTRUMENT CLIMB

1. Establish a rate of climb to obtain approximately 500 feet per minute on the rate-of-climb indicator until normal climbing speed is reached; then trim airplane to maintain this airspeed.
2. Leave traffic and climb to assigned flight altitude in accordance with local air traffic regulations. Do not exceed a 30-degree bank during climbing turns.

INSTRUMENT CRUISING FLIGHT.

Since trim of the airplane will change rapidly when speed is increased or decreased, adjustment of the trim tabs will be necessary until speed is stabilized. Since no aileron trim facilities are provided, balance the airplane laterally by maintaining an even fuel level. While changing cruising airspeed, momentarily overpower or underpower (3 to 5 in. Hg) beyond the desired power setting for a quicker response. The recommended airspeeds, shown in the following chart, will provide a safe margin above stall and good controllability for practice instrument flight. Power settings shown in the figure below will normally give standard airspeeds listed.

INSTRUMENT CRUISING FLIGHT

Recommended Airspeeds	RPM	Approx Man. Press. (in. Hg)	Mixture
Climb to cruising altitude — 110 mph IAS	**2000**	**30**	**Mixture adjusted for smoothest operation above 3000 feet.**
Slow cruise — 110 mph IAS	**1850**	**18**	
Normal cruise — 130 mph IAS	**1850**	**21**	
Fast cruise — 140 mph IAS	**1850**	**24**	
Climb — 500 fpm — 110 mph IAS	**1850**	**25**	
Descent — 500 fpm — 110 mph IAS	**1850**	**13**	
GCA airspeed —20 degree flaps — 100 mph IAS	**2000**	**16-18**	**RICH**

> **NOTE:** If landing gear is extended, the power settings should be slightly higher.

DESCENT

Normal descent procedures are followed.

HOLDING

If holding is necessary for an extended period, fuel can be conserved by using a power setting of 1600 rpm and enough manifold pressure to maintain an airspeed of 100 mph IAS.

INSTRUMENT APPROACHES

Radio range let down and low visibility approaches are standard.

GROUND CONTROLLED APPROACH

Procedure for landing under instrument conditions by use of directions from ground controlled approach radar equipment after let down on a radio range is as follows:

1. Establish contact with GCA over GCA.pickup point.
2. Hold 110 mph IAS until final turn is completed, running through GCA pre-landing cockpit check as instructed by GCA controller.
3. After completing turn to final approach and prior to intercepting the glide path, lower flaps 20 degrees.
4. As glide path is intercepted, reduce throttle setting to obtain 17 in. Hg manifold pressure and descend as directed by the GCA final controller.

ICE AND RAIN

During a winter fog or rain, watch for icing on wings from propeller blast during engine run-up. Don't take off in sleet if you can avoid it, because it may freeze on the wings before you can gain altitude. If carburetor ice has formed during group operation, use carburetor heat to remove ice prior to take-off and as necessary during take-off.

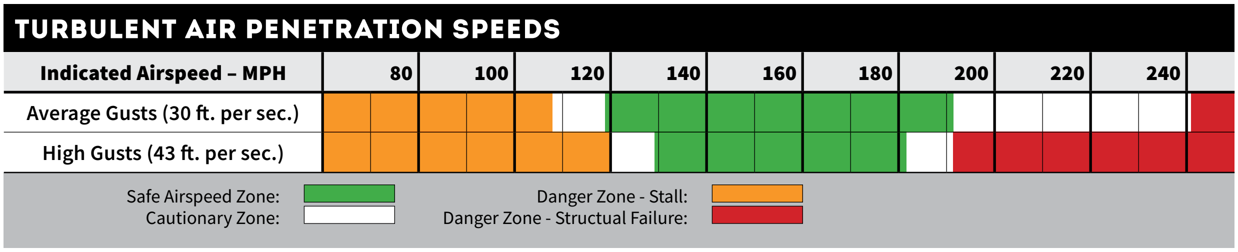
> **WARNING:** The carburetor is susceptible to icing and may ice up at any time under actual instrument flight conditions. Except in extreme cases, carburetor mixture temperatures of approximately 3 ° C will be sufficient to clear the carburetor or prevent icing.

Engine roughness and a slight drop in manifold pressure are indications of ice forming in the carburetor. If carburetor icing is ·indicated, carburetor heat should first be applied at a somewhat higher temperature than is normally used and then readjusted as necessary to prevent further icing. Fuel consumption will increase slightly with the application of carburetor heat. If icing is encountered during low rpm operation, increase the engine speed and manifold pressure and enrich the mixture.

If ice has accumulated on wings, make wide, shallow turns at a speed greater than normal, especially during the approach. Use flaps with care. Remember, stalling speed increases with ice. The only units that incorporate provisions to prevent icing are the pitot head and carburetor. Additional information concerning carburetor icing is given in Systems chapter.

FLIGHT IN TURBULENCE AND THUNDERSTORMS.

Since circumstances may force you at some time to enter a zone of severe turbulence, you should be familiar with the techniques recommended for flying under such circumstances. Power setting and pitch attitude are the keys to proper flight technique in turbulent air. The power setting and pitch attitude for the desired penetration airspeed should be established before entrance into the storm and, if maintained throughout the storm, should result in a constant airspeed regardless of any false indications by the airspeed indicator. Instructions for preparing to enter a storm and flying in it are given in the following paragraphs.



TURBULENT AIR PENETRATION SPEEDS

Indicated Airspeed – MPH	80	100	120	140	160	180	200	220	240	
Average Gusts (30 ft. per sec.)	🟧🟧	🟧🟧	🟧⬜	🟩🟩	🟩🟩	🟩🟩	🟩⬜	⬜⬜	⬜⬜	🟥
High Gusts (43 ft. per sec.)	🟧🟧	🟧🟧	🟧🟧	⬜🟩	🟩🟩	🟩🟩	⬜🟥	🟥🟥	🟥🟥	🟥

Safe Airspeed Zone: 🟩
Cautionary Zone: ⬜
Danger Zone - Stall: 🟧
Danger Zone - Structual Failure: 🟥

BEFORE TAKE-OFF

Perform the following checks before take-off when flight through a storm is anticipated:

1. Check Turbulent Air Penetration Speed chart for best penetration speed.
2. Make a thorough analysis of the general weather to determine thunderstorm areas, and prepare a flight plan that will avoid thunderstorm areas whenever possible.
3. Be sure to check proper operation of all flight instruments, navigation equipment, pitot heater, carburetor air heater, and panel lights before attempting flight through thunderstorm areas.

APPROACHING THE STORM.

It is imperative that you prepare the airplane prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity can be detected by radio crash static. Prepare the airplane as follows:

1. Accurately fix position before actual entry into thunderstorm area.
2. Propeller control set to obtain 1900 rpm for gyroscopic stability.
3. Mixture control adjusted for smooth engine operation.
4. Pitot heater switch ON.
5. Carburetor air control adjusted as required.
6. Throttle adjusted as necessary to obtain. desired penetration speed.
7. Check suction gage for proper reading and gyro instruments for correct settings.
8. Tighten safety belt. Lock shoulder harness.
9. Turn off any radio equipment rendered useless by static.
10. To minimize the blinding effect of lightning at night, turn cockpit lights full bright or use dark glasses, adjust seat low, and don't stare outside airplane.

CAUTION: When flying through turbulent air, do not lower gear and flaps, as they decrease the aerodynamic efficiency of the airplane.

IN THE STORM

While flying through the storm, observe the following precautions:

1. Maintain, throughout the storm, the power setting and pitch attitude established before entering the storm. Hold these constant and your airspeed will be constant, regardless of the airspeed indicator.
2. Maintain attitude. Concentrate principally on holding a level attitude by reference to the gyro horizon.
3. Maintain original heading. Do not make any turns unless absolutely necessary.
4. Don't chase the airspeed indicator, since doing so will result in extreme airplane attitudes. If a sudden gust should be encountered while the airplane is in a nose high attitude, a stall might easily result. Because of rapid changes in vertical gust velocity or rain clogging the pitot tube, the airspeed may momentarily fluctuate as much as 70 mph.
5. Use as little elevator control as possible to maintain your attitude in order to minimize the stresses imposed on the airplane.
6. The altimeter and rate-of-climb indicator may be unreliable in thunderstorms because of differential barometric pressure within the storm. A gain or loss of several thousand feet may be expected. Altitude must be allowed to vary to let the airplane ride out the storm. Make allowance for this condition in determining a minimum safe altitude.

NOTE: Normally, the least turbulent area in a thunderstorm will be at altitudes between 6000 and 8000 feet above the terrain. Altitudes between 10,000 and 20,000 feet are usually the most turbulent.

7. Maintain a constant power setting and pitch attitude unless airspeed falls off to 60 percent above power-on stalling speed, or unless airspeed increases to approximately 30 percent above maximum penetration airspeed.

COLD WEATHER PROCEDURES

The success of low-temperature operation depends greatly on the preparation made previously during engine shutdown and post flight procedures as outlined in the following paragraphs. Icing conditions, however, are covered in the instructions for instrument flight.

ALL WEATHER OPERATION

BEFORE ENTERING THE AIRPLANE

1. 1. Have "Y" drain and oil tank sump checked for free flow. If no oil flow is obtained, heat should be applied.

   NOTE: If oil was not diluted when the engine was previously shut down, heating will be necessary at temperatures below 2° C (35° F). At temperatures below -l8° C (0° F), heat should be applied to the engine and accessories. Below -30° C (-22° F), it may be necessary to apply heat also to the battery, cockpits, master brake cylinder, and actuating cylinders.

2. Have moisture drained from all fuel tanks and fuel system sumps; if they are frozen, heat should be applied first. Check fuel and oil tank vent lines for free passage.
3. Check gear and shock struts free of dirt and ice.
4. Have protective covers removed from airplane and any snow or ice removed from surfaces, control hinges, propeller, pitot tube, fuel and oil vents, and crankcase breather outlet.
5. Check freedom of propeller periodically to determine engine stiffness. If propeller cannot be moved easily, continue preheat.
6. Have engine cover and ground heater removed.

BEFORE STARTING ENGINE

1. Have external power source connected to conserve battery life for use during in-flight emergencies.
2. Have oil immersion heater removed.
3. Have propeller pulled through at least two revolutions.
4. Prime engine four to six strokes.

   NOTE: Rapid priming action may be necessary to vaporize the fuel sufficiently.

STARTING ENGINE

1. Check propeller control full decrase
2. After engine starts, continue priming until engine is running smoothly.
3. If there is no indication of oil pressure after 30 seconds running, or if pressure drops after a few minutes of ground operation, stop engine and investigate.
4. Use carburetor heat to assist fuel vaporization.

WARM-UP AND GROUND TESTS.

1. Check all instruments for normal operation:
2. When oil temperature and pressure are normal, advance the throttle to 1400 rpm and pull propeller control to full DECREASE position until a drop of 200 rpm is obtained; then return control to full INCREASE position. Repeat procedure three times to ensure that hot oil is in propeller dome.
3. Operate wing flaps through at least one complete cycle.
4. Perform all ground tests requiring electrical power before disconnecting external power source.

   NOTE: The battery cannot carry the electrical load imposed by ground operation of pitot heater and radios. Minimize load on the electrical system until the generator "cuts in."

5. Have external power source disconnected and turn battery-disconnect switch ON.

TAXIING INSTRUCTIONS

Use only essential electrical equipment to preserve battery life while taxiing at low engine speeds. Avoid slushy and icy areas. Apply brakes cautiously to prevent skidding. Avoid taxiing in deep snow, as steering and taxiing are extremely difficult and frozen brakes are likely to result.

BEFORE TAKE-OFF

1. Check controls very carefully for free and proper movement.
2. Hold brakes and run up engine to 2000 rpm until spark plugs have burned clean and engine is operating smoothly. Then check magnetos.
3. Apply carburetor heat as necessary to maintain carburetor mixture temperature within limits during take-off.
4. Place pitot heat switch ON just before rolling into position for take-off.

TAKE-OFF

At start of take-off run, advance throttle rapidly to take-off setting and check that full power is available.

If full power is not obtained, immediately discontinue take-off. Since cold, dry air has a greater density, engine power output and airplane lift are increased.

AFTER TAKE-OFF

After take-off from a wet snow- or slush-covered field, operate the landing gear and flaps through several complete cycles to prevent their freezing in the retracted position. Expect considerably slower operation of the landing gear and flaps in cold weather.

CLIMB

Adjust carburetor air control as necessary to prevent carburetor icing.

DURING FLIGHT

1. At low outside air temperatures, especially during low-power cruising operation, the fuel-air mixture ratio may be too cold for proper vaporization and fuel economy. Use carburetor heat as necessary to obtain smooth engine operation and to eliminate plug fouling.
2. Operate propeller control every 30 minutes, obtaining approximately a 300 rpm increase and decrease from cruising position; then return to cruise rpm. Otherwise, oil may congeal in propeller hub.
3. Adjust cockpit heat as necessary.

DESCENT

1. Use power during the descent to prevent engine from being cooled too rapidly.
2. Increase carburetor heat as necessary.
3. Mixture control RICH.

APPROACH

1. Make a longer, lower approach than normal so that some power is needed to reach the runway. Use carburetor heat.

2. Pump brake pedals several times to be sure adequate braking is available.

LANDING

Use normal landing procedure.

BEFORE LEAVING THE AIRPLANE

1. Release the brakes.
2. Check dirt and ice removed from shock struts.
3. Inspect oil and fuel tanks and engine breather to verify absence of any accumulated ice.
4. Leave canopy partially open to prevent cracking of transparent areas due to differential contraction. Air circulation also retards formation of frost.
5. Have protective covers installed.
6. Have oil tank sump, "Y" drain, and fuel sumps drained of condensation approximately 30 minutes after stopping the engine. If the airplane is to be idle for several days, the oil should be drained.
7. If specific gravity of battery is less than 1.250, have battery removed for service. If layover of several days is anticipated, or if temperature is below -29° C (-20° F) and airplane will be idle more than 4 hours, have the battery removed.

OPERATION LIMITATIONS

Some of the recommended operating conditions of the airplane or its component systems can be exceeded in the air or on the ground. The gages that indicate these operating ranges are marked in red to show the maximum safe limit. Instrument markings showing the various operating limits are illustrated in the figure below. The proper mixture control settings for the respective indicator readings are shown in the figure below. In some cases, the markings represent limitations that are self explanatory and therefore are not discussed in the text. Operating restrictions or limitations which do not appear as maximum limits on the cockpit instruments are completely discussed in the following paragraph.

MINIMUM CREW REQUIREMENTS

Solo flight is permissible in this airplane; however, on solo flights the airplane must be flown from the front cockpit. Solo flight from the rear cockpit is prohibited because of insufficient controls and visibility restrictions.

ENGINE LIMITATIONS

The maximum allowable engine overspeed is 2800 rpm for 30 seconds.

> **WARNING:** Whenever engine speed exceeds the operating limits, the airplane should be landed immediately at the nearest base. The reason for the overspeed (if known), the maximum rpm, and duration will be entered in Form 1 and reported to the maintenance officer. Overspeed between 2800 and 2900 rpm will necessitate an inspection of the engine before the next flight. If the rpm exceeded 2900, the engine will be removed for overhaul.

PROPELLER LIMITATIONS

Because of undesirable harmonic vibration frequencies, prolonged ground operation between 1450 and 1800rpm is prohibited on airplanes equipped with round tip propeller blades.

AIRSPEED LIMITATIONS

The red line on the airspeed indicator marks the limit dive speed at any altitude. However, the airplane should not be dived to airspeeds in excess of those where light to moderate airplane or surface control buffet is experienced. The yellow line indicates the maximum airspeed at which the flaps may be lowered to the full down position. The maximum airspeed for landing gear down is not marked on the airspeed indicator, but is given below the indicator. Lowering either the flaps or gear at speeds in excess of the flaps-down or gear-down limit airspeeds may cause structural damage to the airplane. Because of the danger of accidental stalls, the minimum permissible indicated airspeed during sideslips is 90 mph.

PROHIBITED MANEUVERS

Outside loops, inverted spins, snap rolls in excess of 130 mph, and slow rolls in excess of 190 mph are prohibited. Inverted flight must be limited to 10 seconds, as there is no means of ensuring a continuous flow of fuel or oil in this attitude. Since altitude is lost rapidly during a sideslip, this maneuver should not be attempted below 200 feet.

G-LOAD LIMITATIONS

The airplane is limited to a maximum positive G-load of 5.67 and a maximum negative G-load of -2.33. These acceleration limits apply only when the clean airplane gross weight does not exceed 5300 pounds (design gross weight). When airplane gross weight is greater than 5300 pounds, the maximum allowable G-load is less than the maximum limit marked on the accelerometer.

Remember that when you pull the maximum G-load (5.67 G), the wings of your airplane must support 5.67 times their normal load. This means that during a maximum G pull-out the wings of the airplane (at design gross weight) are supporting 5.67 times 5300 pounds or a total of approximately 30,000 pounds (the maximum that the wings can safely support). Therefore, when your airplane weighs more than 5300 pounds, the maximum G-load that you can safely apply can be determined by dividing 30,000 by the new gross weight.

The maximum G-loads we have been talking about apply only to straight pull-outs. Rolling pull-outs are a different story, however, since they impose considerably more stress upon the airplane. The maximum allowable G-load in a rolling pull-out is limited to two thirds the maximum G-load for a straight pull-out.

CENTER-OF-GRAVITY LIMITATIONS

The only adverse CG location that can occur is a tail heavy condition caused by an excessive baggage load.

This will result if more than 100 pounds of baggage is carried on a solo flight or, on flights with both pilots, when more than 15 pounds of baggage is carried on some airplanes or more than 35 pounds of baggage is carried on other airplanes.

WEIGHT LIMITATIONS

The maximum allowable gross weight of the airplane cannot be exceeded. The baggage compartment should not be loaded in excess of its maximum capacity of 100 pounds.

OPERATION LIMITATIONS

CYLINDER HEAD TEMP

🟩	150°-232°C	Manual Lean Permitted
🟨	232°-260°C	Rich Required
🟥	260°C	Maximum

CARBURETOR MIXT. TEMP

🟨	-10° to +3°C	Danger of Icing
🟩	3° to 15°C	Continuous Operation
🟥	15°C	Maximum – Danger of detonation

POWER LIMITS BASED ON FUEL GRADE 91/96

MANIFOLD PRESSURE

🟩	17.5 in. Hg	Minimum Recommended in flight
🟩	17.5-26 in. Hg	Manual Lean Premitted
🟨	26-32.5 in. Hg	RICH required
🟨	32.5 in. Hg	Maximum Continuous (Operation above this point limited to 5 min)
🟥	36 in. Hg	Take-off (Military)

TACHOMETER

🟩	1600 rpm	Minimum Recommendedin flight
🟩	1600-2000 rpm	Manual Lean Premitted
🟨	2000-2200 rpm	Rich Required
🟨	2200 rpm	Maximum Continuous (Operation above this point limited to 5 min)
🟥	2250 rpm	Take-off (Military)

OIL TEMPERATURE

🟥	40°C	Minimum for flight
🟩	60°-80°C	Continuous Operation
🟥	95°C	Maximum

OIL PRESSURE

🟥	50 psi	Minimum for flight
🟩	70-90 psi	Continuous Operation
🟥	100 psi	Maximum

FUEL PRESSURE

🟥	3 psi	Minimum for flight
🟩	3-4 psi	Continuous Operation
🟥	6 psi	Maximum

ENGINE GAGE UNIT

AIRSPEED

🟥	240 mph	Maximum
⬜	125 mph	Full Flaps (Landing Gear – 150 mph)

ACCELEROMETER

🟥	5.67 G	Maximum Postitive at 5300 lb.
🟥	-2.33 G	Maximum Negative at 5300 lb.

HYDRAULIC PRESSURE

🟩	900-1150 psi	Normal
🟥	1150 psi	Maximum

SUCTION

🟥	3.75 in. Hg	Minimum
🟩	3.75-4.25 in. Hg	Normal
🟥	2.25 in. Hg	Maximum

FLIGHT CHARACTERISTICS

The airplane has good stability and control characteristics and when properly trimmed will tend to maintain level flight.

MANEUVERING FLIGHT

Rapid airplane response to flight control movement during the normal speed range provides good acrobatic characteristics in this airplane. However, elevator stick forces in turns and pull-outs are purposely higher than elevator stick forces in fighter-type airplanes. This feature is to help you prevent imposing an excessive G-load on the airplane during acrobatics.

> **CAUTION:** Do not trim the airplane during any acrobatic maneuvers in an attempt to reduce stick forces, as only small elevator stick forces are then required to exceed the structural limits for the airplane.

FLIGHT CONTROLS

All flight controls are very effective throughout the normal speed range, and only moderate stick movement is required to maneuver the airplane. At high speeds, the airplane response to control movement is greater than at cruise speeds, and abrupt movement of the controls must be avoided to prevent exceeding the G-limit of the airplane. Near stalling speeds the ailerons are least effective, the rudder is fairly effective, and the elevator is very effective. Rapid elevator movements at low speed should be avoided to prevent an unintentional stall. Elevator and rudder trim tab adjustments are sufficient to trim elevator stick forces and rudder pedal forces to zero throughout the normal speed range. Right rudder pedal force may be required during low-speed full power conditions. The aileron trim tab is not adjustable from the cockpit.

SPINS

The spin characteristics remain essentially the same whether the gear and flaps are up or down or whether the spin is to the left or the right. Some slight difference in the magnitude of the oscillations and canopy vibration may be noted. Normal spin entry is accomplished in the conventional manner by application of full rudder in the desired direction at point of stall and simultaneous application of full back stick with ailerons neutral. These control positions must be held with the spin until the desired number of turns has been completed, The minimum altitude for intentionally entering a spin is 10,000 feet above the terrain. (Inverted spins are prohibited.)

SPIN RECOVERY

Recovery from normal or inverted spins is effected by vigorous application of full opposite rudder followed by stick movement (slightly forward of neutral for normal spins and slightly aft of neutral for inverted spins).

Leave ailerons neutral. Immediately following application of recovery controls, the nose of the airplane will drop and the spin will accelerate rapidly for approximately one-half to three-fourths turn. Hold the controls in this position until the spin stops; then immediately relax rudder pressure to neutral. Slowly apply back pressure on the stick to round out the dive and regain level-flight attitude. During the final recovery from an inverted spin, you may half-roll from the inverted dive before applying back pressure on the stick to round out the dive. Move throttle slowly to cruise setting after level-flight attitude is attained. Elevator stick forces during recovery will be lighter if the elevator trim adjustment is maintained for the level-flight cruise condition.

STALLS

Stalls in this airplane are not violent. You can feel a normal stall approaching as the controls begin to loosen up and the airplane develops a sinking, “mushy” feeling. In addition, you can see the stalling attitude. When the stall occurs, there is a slight buffeting of the elevator and a vibration of the fuselage, and the nose or a wing drops. Stalling speeds with gear and flaps up or down power on or off-with different gross weights at varying degrees of bank are different.

STALL RECOVERY

The importance of proper stall recovery technique cannot be stressed too much. Because the elevator is very effective at stalling speeds, recovery is quick and positive. However, rough elevator use or failure to regain sufficient flying speed following a normal stall can cause an accelerated or high-speed stall. You can recover from partial stalls by reducing back pressure on the stick or by adding sufficient power to maintain control of the airplane. The standard procedure for recovering from a stall is as follows:

1. Move stick forward quickly and smoothly. To prevent an undesirable nose-low attitude and possible momentary engine stoppage, avoid jamming or snapping the stick forward abruptly.
2. At the same time, advance the throttle in a smooth movement to the sea-level stop.

> **NOTE** Be sure to move the stick and throttle together smoothly. Do not allow the nose to drop too far below the horizon.

3. Use rudder to maintain directional control. Ignore wing attitude until the stall is broken, at which time aileron effectiveness returns.
4. As soon as the stall is broken, utilize all controls in a co-ordinated manner to resume normal flight.
5. When you attain safe flying speed, raise the nose to level flight with steady back pressure on the stick. Avoid abrupt changes of attitude.
6. Retard throttle to cruising power after levelling off.

PRACTICE STALLS

The following practice manoeuvres will acquaint you with the stall traits and speed of the airplane under various flight conditions. For both power-on and power-off stalls, set the propeller control to obtain 1850 rpm. This setting will prevent engine limitations from being exceeded accidentally during recovery. Retard the throttle smoothly for power-off stall; set manifold pressure at 25 in, Hg for power-on stalls. Canopies should be closed during practice stalls to prevent exhaust flame from entering cockpit in case of a backfire.

PRACTICE STALL - GEAR AND FLAPS DOWN, POWER OFF, STRAIGHT AHEAD.

Set propeller control for 1850 rpm and mixture control for smooth operation. Close the throttle and maintain altitude. When airspeed approaches approximately 110 mph, lower full flaps. Establish a 90-mph glide and trim the airplane. Pull the nose up to a three-point attitude and hold until the stall occurs. Observe the qualities of the airplane in the stall. Note the feel. After the airplane breaks to the right or left or stalls straight ahead, perform a standard stall recovery as the nose passes through the horizon. Raise the landing gear and raise the flaps in slow stages as soon as possible. Retard the throttle to 25 in. Hg manifold pressure.

PRACTICE STALL - GEAR AND FLAPS UP, POWER ON, STRAIGHT AHEAD.

Raise nose to approximately 40 degrees above the horizon. Hold this attitude with wings level and nose steady. As the stall approaches, observe the looseness of the controls, attitude of the airplane, and the tone of the engine. Notice how the airplane shudders when the stall occurs. As the stall occurs, apply brisk forward pressure to the stick and, at the same time, advance the throttle to the sea-level stop.

Use rudder to maintain directional control; then blend in aileron as it becomes effective with the increase in airspeed.

When flying speed is reached, ease airplane out of dive and back to cruising attitude and reduce throttle to 25 in. Hg manifold pressure.

PRACTICE STALL - GEAR AND FLAPS UP, POWER ON, 20 DEGREE BANK.

Enter a coordinated climbing turn with a bank of approximately 20 degrees. Raise the nose approximately 40 degrees

above the horizon. Keep the nose turning at a steady rate until the stall occurs. When the stall occurs, apply brisk forward pressure to the stick and advance the throttle to the sea-level stop. When you have enough flying speed to make ailerons effective, make a coordinated roll out of the turn and dive. Return to level flight as in straight-ahead stalls. Reduce throttle to 25 in. Hg manifold pressure.

PRACTICE STALL - GEAR DOWN, FLAPS UP, POWER OFF, STRAIGHT AHEAD.

Close throttle completely, reduce airspeed to 100 mph IAS, and establish a normal glide. Re-trim. Raise the nose to a landing attitude and hold it on a point straight ahead until the stall occurs. As you approach the stall, observe the looseness of controls, the “mushy” feeling of the airplane, and the dwindling airspeed. Remember, this is like a landing stall. Use standard recovery procedure. Reduce throttle to 25 in. Hg manifold pressure and raise the landing gear.

PRACTICE STALL - GEAR DOWN, FLAPS UP, POWER OFF, 40 DEGREE BANK.

This maneuver will help you recognize the stalls which may occur in power-off turns in traffic or landings. Assume a normal glide of 100 mph; then roll into a medium gliding turn with about 40 degrees of bank. Maintain a steady turn, raising the nose slightly until it is just above the horizon. It is necessary to increase back pressure on the stick to hold this attitude until the stall occurs. Make a standard recovery. After recovering speed, use coordinated controls to level the airplane. Reduce the throttle to 25 in. Hg manifold pressure and raise the landing gear.

DIVES

The handling characteristics in dives to the limit airspeed are good. All control movement is easy and effective, and the airplane responds rapidly. If you trim the airplane for level flight at Maximum Continuous Power, the tab settings will be satisfactory for diving, although some adjustment of rudder tab may be desired during the dive so that you will not have to hold rudder. The amount of forward stick pressure required to hold the airplane in a dive is relatively small, as is the amount of aileron pressure needed to keep the wings level. Before entering a dive, close the canopy and position the carburetor air control to COLD. Decrease rpm as necessary during the dive to prevent exceeding maximum engine overspeed limits.

SYSTEMS

It is often asked what the consequences would be if the 5-minute limit at Take-off Power were exceeded. Another frequent inquiry is how long a period must be allowed after the specified time limit has elapsed until Take-off Power can again be used. These questions are difficult to answer, since the time limit specified does not mean that engine damage will occur if the limit is exceeded. Instead, the limit means to keep the total operating time at high power to a reasonable minimum in the interest of prolonging engine life.

It is generally accepted that high-power operation of an engine results in increased wear and necessitates more frequent overhaul than low-power operation. However, it is apparent that a certain percentage of operating time must be at full power. The engine manufacturer allows for this in qualification tests in which much of the running is done at Take-off Power to prove ability to withstand the resulting loads. It is established in these runs that the engine will handle sustained high power without damage. Nevertheless, it is still the aim of the manufacturer and to the best interest of the pilot to keep within reasonable limits the amount of high power time accumulated in the field. The most satisfactory method for accomplishing this is to establish time limits that will keep pilots constantly aware of the desire to hold high-power periods to the shortest period that the flight plan will allow, so that the total accumulated time and resulting wear can be kept to a minimum.

How the time at high power is accumulated is of secondary importance; i.e., it is no worse from the standpoint of engine wear to operate at Take-off Power for one hour straight than it is to operate in twelve 5-minute stretches, provided engine temperatures and pressures are within limits. In fact, the former procedure may even be preferable, as it eliminates temperature cycles which also promote engine wear. Thus, if flight conditions occasionally require exceeding time limits, this should not cause concern so long as constant effort is made to keep the over-all time at Take-off Power to the minimum practicable.

Another factor to be remembered in operating engines at high power is that full Take-off Power is to be preferred over take-off rpm with reduced manifold pressure. This procedure results in less engine wear for two reasons. First, the higher resulting brake horsepower decreases the time required to obtain the objective of such high-power operation. At take-off, for example, the use of full power decreases the time required to reach an altitude and airspeed where it is safe to reduce power and shortens the time required to reach the airspeed that will provide more favourable cylinder cooling. Second, high rpm results in high loads on the reciprocating parts because of inertia forces. As these loads are partially offset by the gas pressure in the cylinder, the higher cylinder pressures resulting from use of full take-off manifold pressure will give lower net loads and less wear. Sustained high rpm is a major cause of engine wear. It requires more “rpm minutes” and “piston-ring miles” to take off with reduced manifold pressure. In addition to the engine wear factor, a take-off at reduced power is comparable to starting with approximately one-third of the runway behind the airplane. Therefore full power should always be used on all take-offs.

MANUAL LEANING.

An important factor affecting engine power output is the fuel-air ratio of the inlet charge going to the cylinders. Since air density decreases with altitude, the mixture control must be manually adjusted to maintain a proper mixture. However, lean mixtures must be avoided, especially when the engine is operating near its maximum output. If is well to closely observe the cylinder head temperature whenever lean mixtures are used. If the mixture is too lean, one or more of the following operational difficulties may result: rough engine operation, backfiring, overheating, detonation, sudden engine failure, or appreciable loss in engine power. Adjusting the mixture for smooth operation is accomplished by slowly pulling the mixture control toward LEAN until the engine definitely falters; immediately push the control slightly forward until the engine again runs smoothly. Then slowly push the control approximately 1/4 inch toward RICH.

THROTTLE “JOCKEYING.”

Since there is no advantage to “jockeying” the throttle, and because it can result in damage to the engine, it should be avoided. “Jockeying” the throttle when the engine is cold frequently causes backfire with accompanying fire hazard. When the engine is hot, “jockeying” the throttle will tend to “load up” and possibly choke the engine.

CHANGING ENGINE POWER SETTINGS.

One of the basic limitations placed on engine operation is imposed by the amount of pressure developed in the cylinders during combustion. If this pressure becomes excessive, it can cause detonation and will result in eventual engine failure. Since improper co-ordination in the use of the throttle and propeller control can cause these limitations to be exceeded, it is important to learn the correct sequence in which these controls should be used Whenever the engine power is to be reduced, retard the throttle first; then retard the propeller control.

Conversely, when increasing engine power, advance the propeller control first; then advance the throttle.

CARBURETOR ICING

A characteristic of carburetor icing is that ice will form more readily when the mixture temperature in the carburetor is between -10° C and +3° C. Carburetor icing usually occurs during times when the free air temperature is about + 4° C to + 8° C. Ice will also form more readily when the engine is operated under a low-power cruise condition; therefore, a higher power setting should be selected when icing conditions are prevalent.

The formation of ice can be detected by a gradual decrease of manifold pressure, but rpm will remain constant, as the propeller governor will automatically maintain the existing rpm setting. Moving the carburetor air control to HOT will eliminate the ice in the carburetor, and the manifold pressure will return almost to the original setting. During operation in cold, clear non-icing air where cylinder head and carburetor mixture temperatures drop to values low enough to cause rough engine operation, carburetor heat should be increased just enough to eliminate the roughness.

DETONATION

Detonation is the result of one type of abnormal combustion of part of the fuel-air mixture. The other prevalent form of abnormal combustion is pre-ignition. When detonation occurs, combustion is normal until approximately 80 percent of the charge is burning. At that point, the rate of combustion speeds up tremendously, resulting in an explosion or nearly instantaneous combustion.

This explosion actually pounds the cylinder walls, ‘producing “knock.” This “knock,” or pounding of the cylinder walls, can cause an engine failure. In an airplane, the “knock” is not heard because of other engine and propeller noises. However, detonation can be detected by observing the exhaust for visible puffs of black smoke, glowing carbon particles, or a small, sharp whitish-orange flame.” In addition, a rapid increase in cylinder head temperatures often indicates detonation. When detonation is evident, throttle reduction is the most immediate and surest remedy. When detonation occurs, power is lost. Contributing causes of detonation are as follows:

1. Low octane fuel.
2. High cylinder head temperature caused by too long a climb at too low an airspeed or by too lean a mixture.
3. High mixture temperature caused by use of carburetor heat or by high outside air temperature.
4. Too high manifold pressure with other conditions favorable to detonation.
5. Improper mixture caused by faulty carburetor or too lean a mixture.

PRE-IGNITION

Pre-ignition is closely related to detonation. In fact, detonation often progresses into pre-ignition. When the engine gets too hot, the mixture is ignited before the spark occurs. When this happens, much of the power is wasted trying to push the piston down while it is still rising in the cylinder. The power impulses are uneven, horsepower falls off, and the engine can be damaged from excessive pressures and temperatures.

Pre-ignition may be detected by backfiring through the carburetor and possibly by a rapid increase in cylinder head temperatures. When pre-ignition is encountered, the throttle setting should be reduced immediately.

FUEL SYSTEM FLIGHT OPERATION

During flight, the fuel selector should be moved alternately between 70 GAL LEFT and 70 GAL RIGHT to keep the fuel level in the wing tanks within 10 gallons of each other. When flying below 3000 feet above the ground, it is advisable to select the tank containing more fuel as a safety precaution against inadvertent fuel starvation. Because of fuel cell baffle and flapper valve design, banking maneuvers can “stuff” fuel into the cell enclosure from which fuel quantity is determined. Therefore, the actual quantity of fuel may be less than that indicated on the gage.

PROPELLER OPERATION

The engine speed is maintained constant by a governor, which regulates the engine oil pressure to a piston incorporated in the propeller hub. A counterweight at the shank of each blade provides a force (proportionate to rpm) in opposition to engine oil pressure to effect a balance. The resultant action of the piston varies the propeller blade angle or pitch, thereby maintaining a constant engine rpm. The engine is shut down with the. propeller at decrease rpm (high pitch) so that the oil in the hub piston will be returned to the oil tank. Therefore, the propeller control must be at DECREASE rpm when the engine is again started; otherwise, the immediate demand for oil to change the propeller pitch will decrease the available oil pressure necessary for engine lubrication during the start.

DATA CHARTS

INTRODUCTION

There are two ways to perform a mission. The correct method can be determined from the information presented in the charts, on the following pages. If a pilot chooses to ignore the charts he can fly any mission confident that the airplane is capable of greater performance than he is capable of obtaining from it. These charts, which are easy to interpret, enable you to fly a greater distance at better cruising speed and arrive at your destination with more reserve fuel. A description of each chart and a sample problem to illustrate a typical training mission are also included.

TAKE-OFF DESTANCES -FT.- HARD-SURFACE RUNWAY

Configuration and Gross Weight (lb.)	Pressure Altitude	-5 DEGREES CENTIGRADE				+15 DEGREES CENTIGRADE			
		Zero Wind		30-Knot Wind		Zero Wind		30-Knot Wind	
		Ground Run	To Clear 50 ft. Obst.	Ground Run	To Clear 50 ft. Obst.	Ground Run	To Clear 50 ft. Obst.	Ground Run	To Clear 50 ft. Obst.
6000 lb. Clean	**Sea Level**	1000	1650	350	750	1100	1850	400	850
	1000	1000	1700	350	750	1150	1900	450	850
	2000	1050	1750	400	800	1200	1950	450	900
	3000	1150	1900	450	850	1300	2100	500	1000
	4000	1250	2000	500	950	1400	2200	550	1050
	5000	1350	2150	550	1000	1500	2400	650	1150
5800 lb. Clean	**Sea Level**	900	1550	300	650	1050	1700	350	750
	1000	950	1600	300	700	1050	1750	400	800
	2000	1000	1650	350	750	1100	1850	400	850
	3000	1050	1750	400	800	1200	1950	450	900
	4000	1150	1900	450	900	1300	2100	500	1000
	5000	1250	2050	500	950	1400	2250	600	1100
5500 lb. Clean	**Sea Level**	800	1400	250	600	900	1550	300	700
	1000	850	1450	300	650	950	1600	350	700
	2000	900	1500	300	650	1000	1650	350	750
	3000	950	1600	350	700	1050	1750	400	800
	4000	1000	1700	400	800	1150	1900	450	900
	5000	1100	1850	400	850	1250	2000	500	950
5000 lb. Clean	**Sea Level**	650	1200	200	500	750	1300	250	550
	1000	700	1250	200	500	750	1350	250	600
	2000	700	1300	250	550	800	1400	300	600
	3000	750	1350	250	600	850	1500	300	650
	4000	800	1450	300	650	900	1600	350	700
	5000	900	1550	300	700	1000	1700	400	750

Remarks:
1. Take-off distances are airplane requirements under normal service conditions.
2. Flapps up (0°)
3. RPM = 2240
4. MP = 36.0 in. Hg.

TAKE-OFF DISTANCES

A Take-off Distances chart gives take-off ground run distances and total distances to clear a 50-foot obstacle, tabulated for several different altitudes and temperatures on a hard-surface runway. Distances given are for standard flaps-up take-offs. For a minimum run take-off, Checklists chapter.

-35 DEGREES CENTIGRADE				+65 DEGREES CENTIGRADE			
Zero Wind		30-Knot Wind		Zero Wind		30-Knot Wind	
Ground Run	To Clear 50 ft. Obst.	Ground Run	To Clear 50 ft. Obst.	Ground Run	To Clear 50 ft. Obst.	Ground Run	To Clear 50 ft. Obst.
1250	2000	500	950	1400	2200	550	1050
1300	2050	500	950	1400	2250	600	1100
1350	2150	550	1050	1500	2400	650	1150
1450	2250	600	1100	1600	2500	700	1250
1550	2400	650	1200	1750	2700	750	1350
1700	2600	750	1300	1900	2900	850	1500
1150	1900	450	850	1250	2050	500	950
1200	1950	450	900	1350	2100	550	1000
1250	2050	500	950	1400	2200	600	1100
1350	2150	550	1050	1500	2350	650	1150
1450	2300	600	1100	1800	2500	700	1250
1600	2500	650	1200	1800	2750	800	1400
1050	1700	400	800	1150	1850	450	850
1050	1750	400	800	1150	1900	450	900
1100	1850	400	850	1250	2000	500	950
1200	1950	450	900	1300	2100	550	1000
1300	2050	500	1000	1400	2250	600	1100
1400	2250	600	1100	1550	2450	650	1200
800	1450	300	650	900	1550	350	700
850	1500	300	650	950	1600	350	750
900	1550	350	700	1000	1650	350	800
950	1650	350	750	1050	1750	400	850
1050	1750	400	800	1050	1900	450	900
1150	1850	450	850	1250	2050	500	1000

NORMAL POWER CLIMB

Best climb speed, fuel consumption, time to climb, and rate of climb (all at Maximum Continuous Power) can be determined from the Normal Power Climb chart. A fuel allowance for warm-up, taxi, and take-off is listed in the column labelled ‘’SEA LEVEL.” Fuel requirements listed at other altitudes include this allowance plus the fuel required to climb from sea level. Fuel required for an in-flight climb from one altitude to another is the difference between the tabulated fuel required to climb to each altitude from sea level.

NORMAL POWER CLIMB CHART

Configuration: CLEAN Gross Weight: 6000 lb.							**Configuration: CLEAN Gross Weight: 5800 lb.**					
APPROXIMATE				**MP** (in. Hg.)	**CAS** (MPH)	**Pressure Altitude** (feet)	**CAS** (MPH)	**MP** (in. Hg.)	**APPROXIMATE**			
Rate of Climb (fpm)	From Sea Level								From Sea Level			Rate of Climb (fpm)
	Dist.	Time	Fuel						Fuel	Time	Dist.	
1000	0	0	9	32.5	112	Sea Level	112	32.5	9	0	0	1050
1000	8	5	14	32.5	113	5,000	113	32.5	14	5	9	1050
650	19	11	19	FT	108	10,000	108	FT	19	10	21	700
350	36	21	26	FT	101	15,000	101	FT	24	20	40	400
						20,000	94	FT	37	45	95	60
						25,000						
						30,000						
						35,000						
						40,000						
						45,000						

Configuration: CLEAN Gross Weight: 5500 lb.							**Configuration: CLEAN Gross Weight: 5000 lb.**					
APPROXIMATE				**MP** (in. Hg.)	**CAS** (MPH)	**Pressure Altitude** (feet)	**CAS** (MPH)	**MP** (in. Hg.)	**APPROXIMATE**			
Rate of Climb (fpm)	From Sea Level								From Sea Level			Rate of Climb (fpm)
	Dist.	Time	Fuel						Fuel	Time	Dist.	
1150	0	0	9	32.5	32.5	Sea Level	32.5	32.5	9	0	0	1350
1150	7	5	13	32.5	32.5	5,000	32.5	32.5	13	4	6	1350
800	16	9	18	FT	FT	10,000	FT	FT	16	8	14	1000
500	31	17	23	FT	FT	15,000	FT	FT	20	14	25	650
150	62	35	31	FT	FT	20,000	FT	FT	26	25	45	300
						25,000						
						30,000						
						35,000						
						40,000						
						45,000						

Remarks:

1. Warm-up, taxi and take-off: 9 gal.
2. Recommended climb power: 2200 rpm.

LEGEND

Rate of Climb	Feet Per Minute
Distance	Statue Miles
Time	Minutes
Fuel	US. Gallons
MP	Manifold Pressure
CAS	Calibrated Airspeed
FT	Full Throttle

LANDING DISTANCES.

The Landing Distances chart shows the distances required for ground roll and for landing over a 50-foot obstacle. Distances for landings on a hard surface runway are furnished for several altitudes and gross weights. Best speeds are shown for both power-on and power-off· approach. Distances given are airplane requirements under normal service conditions with no wind and with flaps full down’.

LANDING DISTANCES -FT.-

Gross Weight (lb.)	Best CAS for Approach		Hard-Surface — No Wind							
			At Sea Level		At 2000 ft.		At 4000 ft.		At 6000 ft.	
	Power ON (MPH)	Power OFF (MPH)	Ground Roll	To Clear 50 ft. Obst.	Ground Roll	To Clear 50 ft. Obst.	Ground Roll	To Clear 50 ft. Obst.	Ground Roll	To Clear 50 ft. Obst.
6000	75	80	900	1600	900	1700	1000	1800	1000	1900
5800	75	80	900	1600	900	1700	1000	1800	1000	1900
5500	70	80	800	1500	800	1600	900	1700	900	1800
5000	65	75	700	1400	800	1500	800	1600	900	1700
4500	65	70	600	1300	700	1400	700	1500	800	1600

Remarks:
1. Landing distances are airplane requirements under normal service operations.
2. Flaps down 45°.
3. Approach pwer (at sea level): 2000 rpm, 22 in. Hg manifold pressure.

LEGEND

CAS Calibrated Airspeed
OBST. Obstacle

MAXIMUM ENDURANCE

Airspeeds, power settings, and fuel flow rates for maximum endurance flight are shown in the Maximum Endurance chart for several gross weights and altitudes. The Maximum Endurance chart giving the power settings and fuel flows for maximum time in the air should not be confused with the "MAXIMUM AIR RANGE" section of the Flight Operation Instruction Chart in which the power settings and fuel flows are for maximum distance, not maximum time.

MAXIMUM ENDURANCE CHART

Configuration: CLEAN		**Gross Weight: 5800 lb.**				**Configuration:**		**Gross Weight:**		
APPROXIMATE				**CAS** (MPH)	**Pressure Altitude** (ft.)	**CAS** (MPH)	**APPROXIMATE**			
GPH	Mixture	RPM	MP (in. Hg)				MP (in. Hg)	RPM	Mixture.	GPH
17	ML	1600	21	95	Sea Level					
17	ML	1600	20	95	5,000					
18	ML	1600	19	95	10,000					
19	ML	1600	19	95	15,000					
20	ML	1900	FT	95	20,000					
					25,000					
					30,000					
					35,000					
					40,000					
					45,000					

Configuration:		**Gross Weight:**				**Configuration:**		**Gross Weight:**		
APPROXIMATE				**CAS** (MPH)	**Pressure Altitude** (ft.)	**CAS** (MPH)	**APPROXIMATE**			
GPH	Mixture	RPM	MP (in. Hg)				MP (in. Hg)	RPM	Mixture.	GPH
					Sea Level					
					5,000					
					10,000					
					15,000					
					20,000					
					25,000					
					30,000					
					35,000					
					40,000					
					45,000					

Remarks:

LEGEND

GPH	Fuel Consumption
CAS	Calibrated Airspeed
FT	Full Throttle
ML	Manual Lean

COMBAT ALLOWANCE

The Combat Allowance chart shows the variation with altitude in manifold pressure and fuel flow at Take-off Power (Military Power).

COMBAT ALLOWANCE CHART

Pressure Altitude (ft.)	RPM	MP (in. Hg)	Blower Position	Micture Position	Time Limit (min.)	Limit Cylinder (°C)	Fuel Flow (gpm/eng)
Sea Level	2250	36.0		RICH	5	260	1.20
2,000	2250	36.0		RICH	5	260	1.30
4,000	2250	Full Throttle		RICH	5	260	1.20
6,000	2250	Full Throttle		RICH	5	260	1.04
8,000	2250	Full Throttle		RICH	5	260	.91
10,000	2250	Full Throttle		RICH	5	260	.81
12,000	2250	Full Throttle		RICH	5	260	.72
14,000	2250	Full Throttle		RICH	5	260	.65
16,000	2250	Full Throttle		RICH	5	260	.59
18,000	2250	Full Throttle		RICH	5	260	.54
20,000	2250	Full Throttle		RICH	5	260	.50
22,000							
24,000							
26,000							
28,000							
30,000							
32,000							
34,000							
36,000							
38,000							
40,000							

FLIGHT OPERATION INSTRUCTION CHART

To assist in selecting the engine operating conditions required for obtaining various ranges, a Flight Operation Instruction Chart is provided. The chart is divided into five main columns. Data listed under Column I is for emergency high-speed cruising at Maximum Continuous Power. Operating conditions in Columns II, III, IV, and V give progressively greater ranges at lower cruising speeds. Ranges shown in any column for a given fuel quantity can be obtained at various altitudes by using the power settings listed in the lower half of the chart in the same column. The speeds quoted on the chart are those obtained with gross weight equal to the high limit of the chart weight band. No allowances are made for wind, navigational error, simulated combat, formation flights, etc; therefore, such allowances must be made as required.

USE OF CHART

Enter the chart at a fuel quantity equal to, or less than, the total amount in the airplane minus all allowances. (Ranges listed for each fuel quantity are based on using the entire quantity in level flight, cruising at the recommended operation conditions. Fuel allowance for warm-up, taxi, take-off, and climb is obtained from the Normal

FLIGHT OPERATION INSTRUCTION CHART

CHART WEIGHT LIMITS, 5800 POUNDS OR LESS

Power Limits	**RPM**	**MP in. Hg**	**Blower Position**	**Mixture Position**	**Time Limit**	**Cyl. Temp.**	**Total GPH**
Military	2250	36.0		RICH	5 min.	260°C	72 (SL)

COLUMN I		**FUEL US. GAL.**	**COLUMN II**		**COLUMN III**	
Range In Air Miles			**Range In Air Miles**		**Range In Air Miles**	
Statue	**Nautical**		**Statue**	**Nautical**	**Statue**	**Nautical**
		138	SUBTRACT FUEL ALLOWANCES NOT AVAILABLE FOR CRUISING			
400	350	120	540	470	690	600
340	290	100	450	390	570	500
270	230	80	360	310	460	400
200	170	60	270	230	340	300
130	120	40	180	150	230	200
70	60	20	90	80	110	100

MAXIMUM CONTINUOUS						**PRESS. ALT (ft.)**	**4.50 STAT. (3.90 NAUT.) MI./GAL.**						**5.75 STAT. (4.98 NAUT.) MI./GAL.**					
			APPROX							**APPROX**						**APPROX**		
RPM	**MP (in.)**	**Mix-ture**	**Ttl. GPH**	**TAS**			**RPM**	**MP (in.)**	**Mix-ture**	**Ttl. GPH**	**TAS**		**RPM**	**MP (in.)**	**Mix-ture**	**Ttl. GPH**	**TAS**	
				MPH	**KN**						**MPH**	**KN**					**MPH**	**KN**
						40,000												
						35,000												
						30,000												
						25,000												
2200	FT	RICH	27	180	155	20,000							2200	FT	RICH	27	180	155
2200	FT	RICH	35	195	170	15,000	2200	FT	RICH	35	195	170	2150	FT	RICH	33	190	165
2200	FT	RICH	45	205	175	10,000	2200	FT	RICH	45	205	175	2000	FT	ML	32	190	165
2200	FT	RICH	60	215	185	5,000	2050	29	RICH	43	195	170	2000	28	ML	32	185	160
2200	FT	RICH	54	200	170	Sea Level	2000	30	RICH	41	185	160	1900	30	ML	26	175	150

SPECIAL NOTES

Make allowance for warm-up, take-off and climb plus allowance for wind, reserve, and combat as required.

EXAMPLE

At 5700 lb. gross weight with 100 gal of fuel (after deducting total allowances of 38 gal) to fly 450 stat. air miles at 15,000 ft. altitude, maintain 2200 rpm and FT with mixture set: RICH.

Power Climb chart. Other allowances based on the type of mission, terrain over which the flight is to be made, and weather conditions are dictated by local policy. If your flight plan calls for a continuous flight at reasonably constant cruising power, compute the fuel required and flight time as a single section flight. Otherwise, the flight must be broken up into sections and each leg of the flight planned separately. The flight plan may be changed at any time en route, and the chart will show the balance of range available at various cruising powers and altitudes if the instructions printed at the top of the chart are followed.

DISCLAIMER: During development, A2A concluded after rigorous internal flight testing, the cruise charts in the POH are badly flawed. These charts estimate the speeds based on horsepower, air temperature and altitude predictions and in some cases show the speeds to be far in excess of what the actual aircraft can do. Furthermore, the manual even contradicts these numbers with their own performance readings for IFR flight, based on actual flying conditions, which are in line with our own flight tests. We included these cruise performance charts even though they are not accurate, as this is the same data actual pilots used then and today when operating the airplane. We mostly use these charts to setup specific power settings at various altitudes and be able to make rough estimates of fuel flow and range.

COLUMN IV		FUEL US. GAL.	COLUMN V	
Range In Air Miles			Range In Air Miles	
Statue	Nautical		Statue	Nautical
SUBTRACT FUEL ALLOWANCES NOT AVAILABLE FOR CRUISING		138		
790	680	120	840	730
650	570	100	700	600
520	450	80	560	480
390	340	60	420	360
260	230	40	280	240
130	110	20	140	120

6.57 STAT. (5.70 NAUT.) MI./GAL.						PRESS. ALT (ft.)	MAXIMUM AIR RANGE					
			APPROX							APPROX		
RPM	MP (in.)	Mix-ture	Ttl. GPH	TAS			RPM	MP (in.)	Mix-ture	Ttl. GPH	TAS	
				MPH	KN						MPH	KN
						40,000						
						35,000						
						30,000						
						25,000						
						20,000	2000	FT	ML	21	160	140
						15,000	2000	FT	ML	26	180	155
1850	FT	ML	28	180	155	10,000	1700	FT	ML	24	170	145
1650	28	ML	26	170	145	5,000	1500	26	ML	23	155	135
1600	28	ML	24	155	135	Sea Level	1600	25	ML	20	140	120

LEGEND

ALT: Pressure Altitude
MP: Manifold Pressure
GPH: Gallons Per Hour
TAS: True Air Speed
KN: Knots
SL: Sea Level
FT: Full Throttle
ML: M Anual Lean

INSTRUCTIONS FOR USING CHART: Select figure in FUEL column equal to or less than amount of fuel to be used for cruising. Move horizontolly to right or left and select RANGE value equal to or greater than the statute or nautical air miles to be flown. Vertically below and opposite value nearest desired cruising altitude (AlT), read rpm, manifold pressure (MP), and MIXTURE setting required. Refer to corresponding column and altitude for new power settings when gross weight falls below limits of this chart.

NOTES: Column I is for emergency high-speed cruising only. Columns ll, lll, IV, and V give progressive increase in range at a sacrifice in speed. Air miles per gallon (ML/GAL) (no wind), gallons per hr (GPH), and true airspeed (TAS) are approximate values for reference. Range values are for an average airplane flying alone (no wind).

HANDLING, SERVICE AND MAINTENANCE

This section contains factory recommended procedures for proper ground handling and routine care and servicing of your airplane. It also identifies certain inspection and maintenance requirements which must be followed if your airplane is to retain that new plane performance and dependability. It is wise to follow a planned schedule of lubrication and preventive maintenance based on climatic and flying conditions encountered in your locality.

HYDRAULIC LOCK

Hydraulic lock is a common condition that can affect round / radial engines. As the engine sits idle over many hours, days, or weeks, oil in the engine can seep into the lower cylinders. This oil can fill a cylinder (combustion chamber) to the point where a piston can bind or lock and result in a damaged engine, specifically, a broken rod that connects the piston to the crankshaft. This is why it is important to pull an engine through with your hand prior to starting to confirm there is no oil in the cylinders (must be careful, as even hand propping can damage an engine with hydraulic lock). For the T6, a popular fix is to install a "clean kit" which is basically a drain and tube, that is attached whenever the aircraft sits, so any oil that drains into these lower cylinders drains out through the tube and into a bucket. Attach the oil clean kit whenever the airplane is sitting for more than several hours (remember, time when the computer is off counts in Accu-Sim) to prevent oil from pooling in the lower cylinders. Before flying, detach the unit (oil is automatically put back into the engine when the unit is removed).

WHAT TO DO IF YOU ENCOUNTER HYDRAULIC LOCK:

If while turning the prop by hand and the propeller suddenly stops moving, stop turning the prop as you have likely just experienced hydraulic lock. Open the Fuel & Payload Manager (Shift-4), attach the clean kit and allow several minutes at least for the oil to drain out of the engine and into the bucket. When you remove the oil clean kit, the oil in the bucket is automatically put back into the engine.

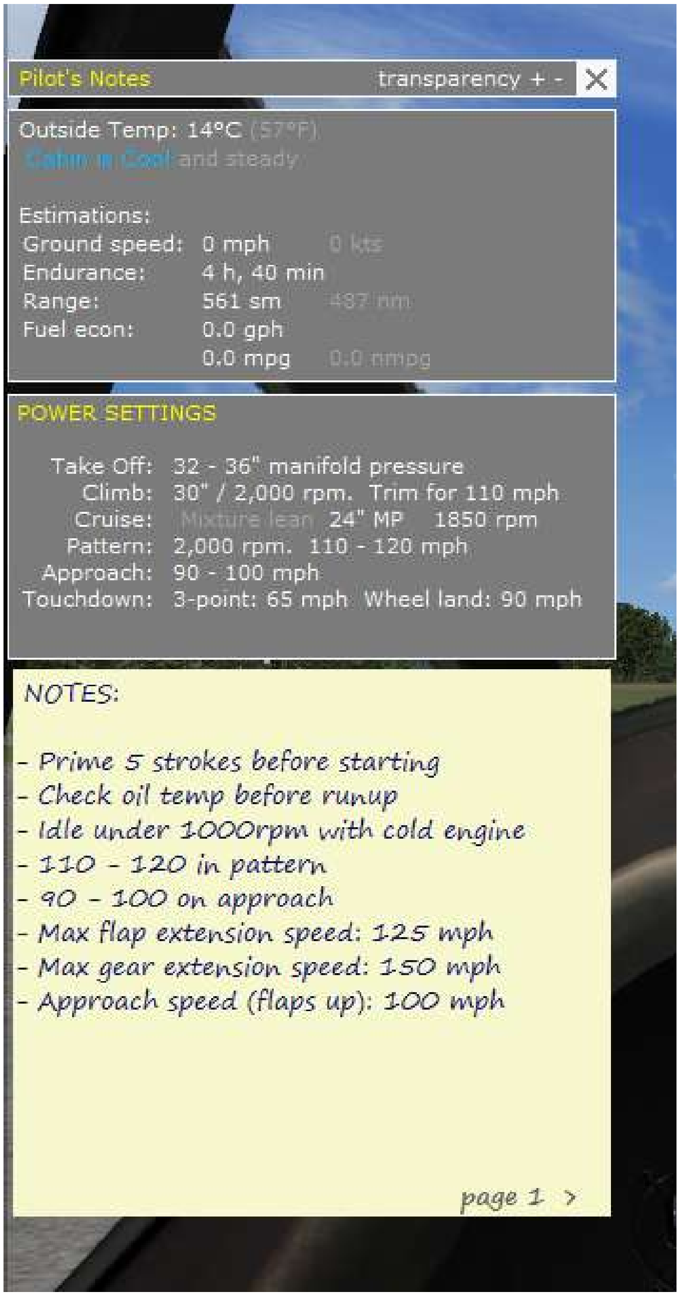
2D PANELS

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

Each 2D panel is accessed by the key-press combination in parentheses after the 2D panel title. If the default commands listed commands don't work please check the mappings in your host simulator under 'Panel Window 1 to 9'

Pilot's Notes (Shift 2)

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



Outside Temp: 14°C (57°F)
Cabin is Cool and steady

Estimations:
Ground speed: 0 mph 0 kts
Endurance: 4 h, 40 min
Range: 561 sm 487 nm
Fuel econ: 0.0 gph
0.0 mpg 0.0 nmpg

POWER SETTINGS

Take Off: 32 - 36" manifold pressure
Climb: 30" / 2,000 rpm. Trim for 110 mph
Cruise: Mixture lean 24" MP 1850 rpm
Pattern: 2,000 rpm. 110 - 120 mph
Approach: 90 - 100 mph
Touchdown: 3-point: 65 mph Wheel land: 90 mph

NOTES:

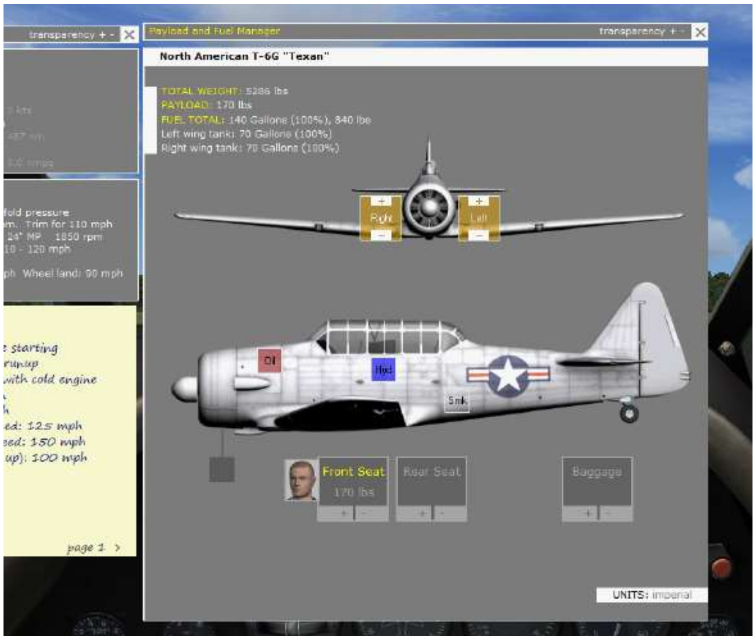
- Prime 5 strokes before starting
- Check oil temp before runup
- Idle under 1000rpm with cold engine
- 110 - 120 in pattern
- 90 - 100 on approach
- Max flap extension speed: 125 mph
- Max gear extension speed: 150 mph
- Approach speed (flaps up): 100 mph

Controls (Shift 3)

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

From this panel, you can:

- Remove the pilot figure from the external view (only available whilst the engine is not running). Note the visual change in the aircraft balance when you remove the pilot.
- Control electrical systems such as the generator or magnetos.
- Toggle aircraft lighting, both internal and external.
- Change the GPS system installed in your aircraft, from a bracket mounted handheld unit, to panel mounted units, or no GPS installed at all.
- Set whether you want the aircraft to already be in a Cold and Dark state when you first enter it.
- Have your aircraft switch to a "Used" state, where some aircraft components will immediately show signs of wear. Check your maintenance hangar before you go flying, so that you're aware of the systems and components that you'll need to keep an eye on.
- Turn Accusim damage on and off.
- Gear Lock Aids: On the T6, each wing has a little clear plastic window that shows the actual gear locking pins. This allows the pilot to visually confirm the gear is locked and down. In the simulator, it can be hard to see these windows as they are close to the fuselage and requires the user to raise and move the eye point. We have included an option to make checking these visual windows easier (shows a mirror image of them up and close to the side windows) considering they need to be checked during a busy time, landing. They appear when you start lowering your landing gear, and based on the option you select, turn off a few seconds after the gear is locked, or upon touching down.
- Hangared: Most Texans today are stored in heated hangars, so we give you this option in the simulator. When the "hangared" option is selected, this simulates your T6 being pulled into a heated hangar after you either load another plane (other than the T6) or exit the simulator. So, for example, if you were to quit the simulator at 12pm, then return at 6pm, the aircraft would come to you as if it was in a heated hangar for 6 hours. The hangar temp is roughly 45 deg F.
- Hand Prop. See Hydraulic Lock on p. 120.



North American T-6G "Texan"

TOTAL WEIGHT: 5286 lbs
PAYLOAD: 170 lbs
FUEL TOTAL: 140 Gallons (100%), 840 lbs
Left wing tank: 70 Gallons (100%)
Right wing tank: 70 Gallons (100%)

Payload and Fuel Manager (Shift 4)

The payload and fuel manager not only gives you an overview of your current payload, fuel and oil quantities, it is also an interactive loading screen, where you can:

- Add and remove passengers and baggage.
- Increase or decrease pilot, passenger and baggage weights.
- Fill engine oil
- Add or remove fuel from the wing tanks.
- Change between viewing weights and measures in imperial or metric format.
- View, at a glance, total aircraft weight, payload weight, and total fuel quantities.
- Oil Clean Kit: Add or remove. See Hydraulic Lock on p. 120

Pilot's Map (Shift 5)

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

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

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

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

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

Quick Radios (Shift 6)

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

Maintenance Hangar (Shift 7)

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

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

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

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

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

COLOR CODES:

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

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

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

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

Compression Test

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

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

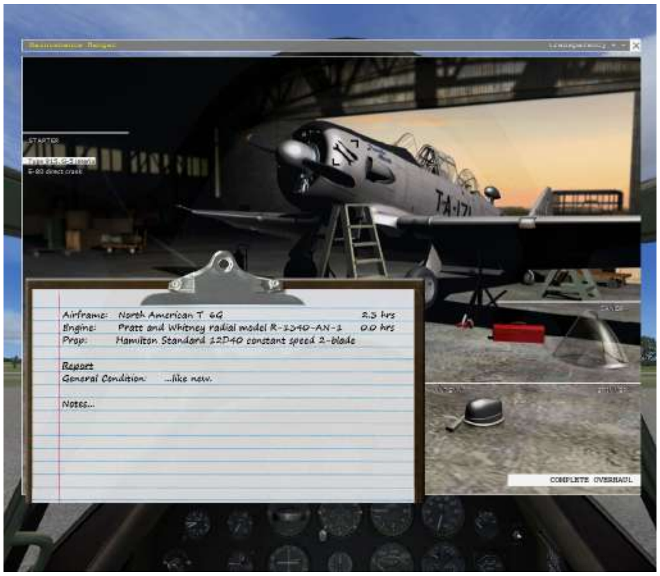
The compressed air would then pass through a calibrated restrictor and to the cylinder pressure gauge. This gauge would show the actual air pressure within the cylinder.

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

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

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

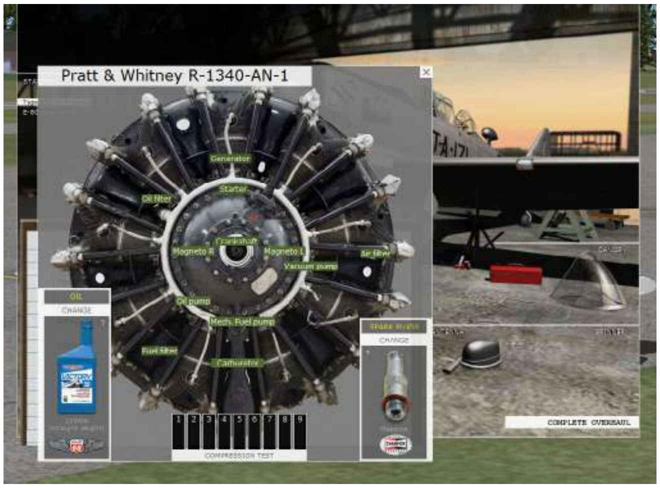
However, note that this is a reading of the general condition of the cylinders, and lower condition does bring additional risks of failure, or even engine fires.



Airframe: North American T 6G 2.5 hrs
Engine: Pratt and Whitney radial model R-1340-AN-1 0.0 hrs
Prop: Hamilton Standard 12D40 constant speed 2-blade

Report
General Condition: ...like new.

Notes...

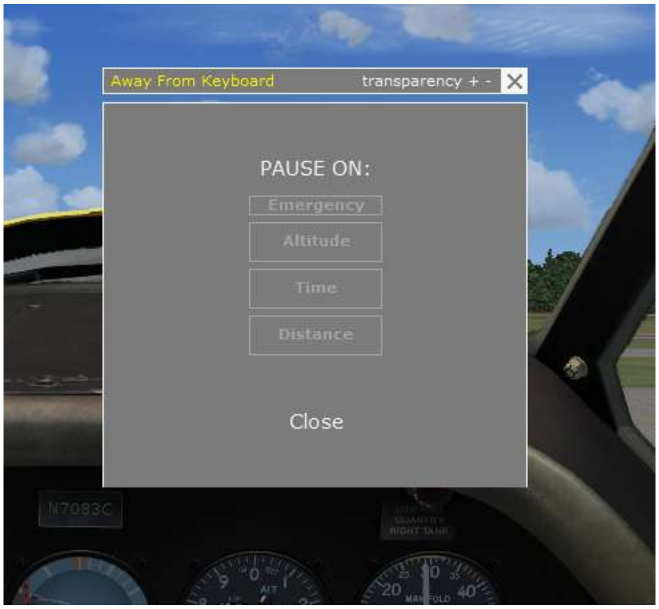


Pause Control (shift 8)

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

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

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



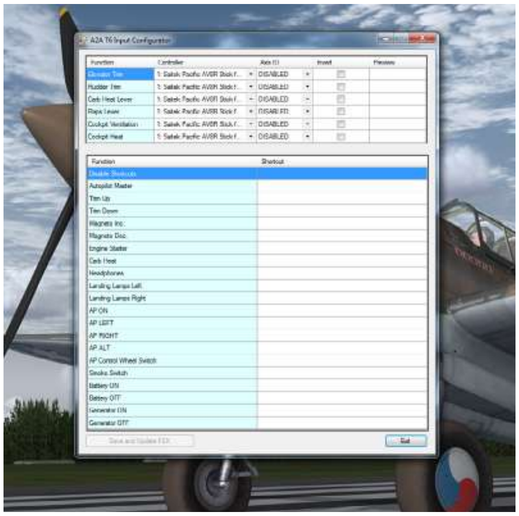
Input Configurator

The Input Configurator allows users to assign keyboard or joystick mappings to many custom functions that can't be found in P3D controls assignments menu. It can be found in the A2A/T6/Tools folder inside your P3D installation directory.

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

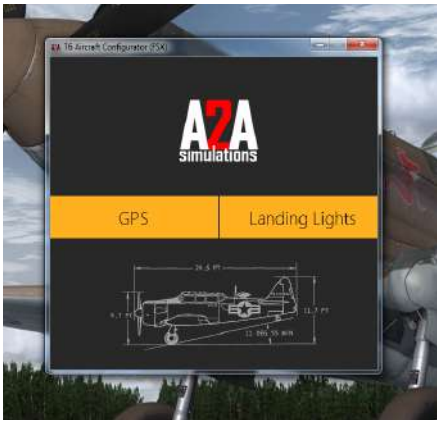
To make a new shortcut, double click on a selected row to bring up the assignment window. Then press keyboard key or joystick button you want to assign to this function. For keyboard it's also possible to use modifier keys (Ctrl, Shift, Alt).

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



Function	Controller	Axis ID	Invert	Preview
Elevator Trim	1: Saitek Pacific AV8R Stick f...	DISABLED	☐	
Rudder Trim	1: Saitek Pacific AV8R Stick f...	DISABLED	☐	
Carb Heat Lever	1: Saitek Pacific AV8R Stick f...	DISABLED	☐	
Flaps Lever	1: Saitek Pacific AV8R Stick f...	DISABLED	☐	
Cockpit Ventilation	1: Saitek Pacific AV8R Stick f...	DISABLED	☐	
Cockpit Heat	1: Saitek Pacific AV8R Stick f...	DISABLED	☐	

Function	Shortcut
Disable Shortcuts	
Autopilot Master	
Trim Up	
Trim Down	
Magneto Inc	
Magneto Dec	
Engine Starter	
Carb Heat	
Headphones	
Landing Lamps Left	
Landing Lamps Right	
AP ON	
AP LEFT	
AP RIGHT	
AP ALT	
AP Control Wheel Switch	
Smoke Switch	
Battery ON	
Battery OFF	
Generator ON	
Generator OFF	



Aircraft Configurator

The Aircraft Configurator for Accu-Sim T-6 Texan enables the user to choose from:

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

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

While the GPS can be changed with or without a running simulation (FSX or Prepar3D), the Landing Lights change takes effect in a next flight of the T-6 Texan.

CREDITS

LOCKHEED MARTIN PREPAR3D
Creators of Prepar3D

INTERNAL AIRCRAFT ARTIST
Michal Puto (lead), Ilona Lazovskaya

EXTERNAL AIRCRAFT ARTISTS
Michal Puto (lead), Marcelo da Silva,

PANEL DESIGNS
Robert Rogalski

PROGRAMMING
Scott Gentile, Robert Rogalski, Michal Krawczyk, Krzysztof Sobczak, Michal Puto

PUBLIC RELATIONS, WEB DESIGN
Lewis Bloomfield

CONSULTANTS
Dudley Henriques (lead), Martin Pengelly

DIRECTOR OF QUALITY CONTROL
Oskar Wagner

VISUAL EFFECTS AND AUDIO
Scott Gentile

MANUAL
Mitchell Glicksman, Scott Gentile

MANUAL EDITING AND PROOFREADING
The Beta Team

MANUAL GRAPHIC DESIGN
Mark Kee

SPONSORS
Phillips66 Aviation, Knots2U, Champion Aerospace, ASL Camguard, Concorde Battery, Lord Corporation, MT Propeller, SuperSoundProofing.

QUALITY CONTROL BETA TEAM:
The world's most effective and knowledgeable flight simulation beta team, includingCody "CodyValkyrie" Bergland, Lewis Bloomfield, Forest "FAC257" Crooke, Glenn "GlennC" Cummings, Ryan "Hog Driver" Gann, Captain Jake Gentile, Mitchell Glicksman, Darryl "Killratio" Hackett, Dudley Henriques, Dave "Slingers" Kingshott, Tom "Tol3458" LeCompte, Matt "mattgn" Newton, Rob "Great Ozzie" Osborne, Ralf "Erlk0enig" Schawer, Gunter "Snorre" Schneider, Erwin "dutch506" Schultze, Guenter "Guenseli" Steiner, Paul "Gypsy Baron" Strogen and Oskar "lonewulf47" Wagner.

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COMMUNITY AND SUPPORT FORUMS:
https://a2asimulations.com/forum/index.php

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