



# Wings of POWER II: B17 Flying Fortress

## Accu-Sim Expansion Pack



## **Foreword**

By Mitchell Glicksman

“The Flying Fortress”, “The Queen of the Skies”, the Boeing Model 229, the B-17 -- it has been known by all of these names, and more. More than merely a famous airplane, it is an iconic symbol of an era and of the struggle and sacrifice of a generation of Americans in the world’s greatest and most horrific conflict against a powerful, implacable, fanatical tyranny. The B-17 also marks a great milestone in aviation history, and a great leap forward in the application of aeronautical and mechanical science and technology. As such it is emblematic of the highest standards of human ingenuity and courageous resolve in the face of terrible adversity.

A2A Simulations has made it possible for all of us to have the opportunity to enjoy the unique, challenging and fascinating experience of flying the most authentic, complete and accurate simulation of the legendary B-17 ever created. The creation and application of the unique, proprietary A2A Accu-Sim system enables us to truly put you in the B-17’s cockpit in a way that only flying the real thing could match. You can almost smell the leather seats, the hot oil, and the pungent exhaust from those four Wright R-1820-97 "Cyclone" turbo-supercharged, 1,200 horsepower radial engines.

To insure the accuracy and fidelity of the simulation, A2A developers have been privileged to take flights in carefully and lovingly maintained B-17’s today with eyes and ears wide open. With multiple cameras rolling and microphones in hand, A2A developers crawled within every nook and cranny of the cockpit so that every sound and sight that a B-17 Pilot would experience is there for you, right down to the wind rushing over the airframe and the characteristic vibrations and tremors of the real aircraft.

As you have come to expect from A2A Accu-Sim aircraft, nothing has been left out that operates in the real aircraft. In fact, there are many features that are included in this simulation that have never before been modeled or included in any other aircraft simulation.

What this means is that when you are flying and operating the A2A Accu-Sim B-17G you will have the uncanny feeling that you are actually in command of a real world B-17. If the engines and the various systems of the simulated B-17 are not operated correctly and as the aircraft manual provides, the airplane will perform less than optimally, and if taken to the extreme, damage and failures will occur just as they would under similar circumstances in the real world.

Occasionally, parts of the airplane will become worn or fail from ordinary use, just as occurs in a real airplane. There is a complete and comprehensive maintenance hanger that you can take your airplane to when on the ground with engines shut down. There you will get a fully detailed, written and illustrated report about the condition of the airplane, and can then authorize recommended repairs. When in the maintenance hanger you will hear typical noises of a repair facility echoing around the vast space such as machinery running, parts and tools falling and clanging to the floor, etc. This kind of intense, authentic pilot experience helps to gives you a sense of total immersion and involvement in day to day life with such a magnificent airplane.

The electrical system seems as if it has actually been wired and hooked up and consists of the lights, landing gear retraction system, flaps, turbochargers, fuel pumps, bomb bay doors, radios and more. They are all electrically powered by the batteries, generators and even an Auxiliary Power Unit (APU) which you can order one of your waist gunners to turn on and off. The voltmeters' readings vary authentically as each item is brought on or taken off line, and as each of the three independent batteries are selected to be read. Electric motors whine with their own unique, authentic sound. You can even hear the sounds of the hydraulic pumps and fluid rushing through the pipes. Vital batteries, motors, and pumps can unexpectedly fail which will test your metal as pilot in command. As a result of this realism, you will get used to going to the maintenance hanger before each flight to see what needs to be done to keep your B-17 in safe and reliable flying condition.

Your crew is interactive and various crewmen will speak to you from time to time to remind you to do various things that you may have forgotten to do (see "THE CREW" below). The Flight Engineer watches the engines and may remind you to give the guys in the back a little heat and your Co-Pilot can even manage the engines for you. If you fly the airplane too roughly, you may get complaints from the crew. Your landings may get compliments if they are good and the reverse if they are not. Various crewmen will report to you as to the position of the landing gear and flaps when you raise or lower them. You are definitely not alone when you are the pilot in command of a capable crew.

Every aspect of the engines and the fuel system has been faithfully modeled as well. Fuel is supplied through gravity-fed tanks, through electrical booster pumps, mechanical fuel pumps, transfer pumps, to large, thirsty rumbling radial engines.

You can select the grades of the fuel and oil to be used on each flight, which will appropriately change how the engines perform. Loading the bird with fuel and feeding one tank with fuel from another in flight is fully functional and accurate in operation to the actual aircraft. You can also cross feed fuel from tanks in one wing to tanks in the other wing. You can opt to carry a center fuselage bomb bay fuel tank for extra range, or bombs, as you choose.

The cowl flaps and inter-cooler doors are fully adjustable; and just as with the propellers, you can set them yourself, or command the Co-Pilot to do it. When you command him to monitor these functions, he will continually set them to keep the engines running cool and at their peak.

The B-17G has a unique turbocharger control -- a numbered wheel for pre-setting the maximum amount of manifold pressure desired when the throttles are fully opened. In the A2A Accu-Sim B-17G you will find this turbocharger control fully and authentically modeled in every detail exactly as in the real world B-17G. You can even calibrate individual turbochargers, just like the real pilots and crew-chiefs do, so that each engine will almost purr in harmony with another.

The Pilot's and Co-Pilot's left and right side windows can be opened to any amount desired. They will fog up if not vented properly, or if the cabin heater is incorrectly set for the outside air temperature.

From time to time, your radioman will contact you on the intercom to tell you that he has picked up something that you might like to hear and that you should switch to the "liaison" channel of your com radio. When you do this, you might hear a song, a news program with a speech by Winston Churchill, a sports report, or some other radio program that would have been broadcast over the radio in Europe during WWII. These recordings are all taken from authentic 1940's broadcasts. At first you will hear static as you approach the station, then the



program will get clearer; and, as you fly away from the station, you will hear static again until the program cannot be heard anymore, as if it was really coming in on a low frequency radio band typical of those days. As you go out of range of the broadcast, the radioman will comment on that. This is a real first in flight simulation, and it adds an uncanny sense of realism, depth, time and place to your sim experience. It's one of my favorite parts of this incredible simulation, and it is a remarkable A2A flight simulation first.

Another nice touch is the feature which allows you to open the bomb bay doors or command the bombardier to do so, and drop the bombs. From the outside, you can watch them fall away, or from inside, you can hear the latches release as your aircraft instantly becomes 6,000 pounds lighter. You can also jettison your internal bomb bay tanks if you wish, which make a characteristic 'whoosh' as those enormous, tall tanks fall into the airstream below.

Here's a real treat for aviation historians and everyone who loves the B-17: A2A has modeled a fully functional, completely accurate and authentic Honeywell 1-C automatic pilot in this simulation. When you access it through 2D pop-up, you will find an exact replica of the C-1 control panel upon which every knob and switch operates and functions exactly as did the real one. Also, you can communicate through the 2D panel with your bombardier, who was a necessary team-mate when operating of this piece of equipment. While this very early auto-pilot was finicky and did not have the simplicity of operation or many of the features of the more modern auto-pilots that we have become accustomed to using, operating this C-1 simulation will let you share the experience which Pilots of the B-17 (as well Pilots of the B-24 and B-29) had when they used this historical piece of aviation equipment. A2A's fully functioning model of the C-1 is but another of the many groundbreaking flight simulation firsts contained in A2A's Accu-Sim B-17G simulation.

The flight model of the A2A Accu-Sim B-17G has been meticulously created to give you the true feeling of flying this heavy, four-engine bomber. Close reference to B-17 Pilot's reports and A2A staff flights in a real B-17 have informed us to the greatest extent possible what flying this airplane feels like. That enormous fin and rudder made turns very smooth and easy. The elevators were sensitive and never lost their effect, even at slow speeds. There was power to spare in those four Wright R-1820-97, 1,200 horsepower engines. Accordingly, the "Fortress" carried herself with grace and ease at all times. Altogether, she was a majestic and gentle airplane and every B-17 pilot we have spoken to and every pilot's report we have come across has said without reservation that she was a joy to fly.

The A2A staff has meticulously and professionally recorded every sound that is heard when operating and flying a B-17G, from the powerful engines to the smallest switch in the cockpit. The airframe groans if you strain it too hard, the wind whistles outside according to the airspeed and, if you open either or both of the cockpit windows you will hear the engines louder outside the window and hear the wind whip into the cockpit, just as with the real airplane. The brakes and tires squeal appropriately when they are pushed hard. Every control, switch, knob and device that makes a sound in the real-world B-17G has been recorded and included in this simulation in order to immerse and involve you as completely as possible. Switches and knobs click from position to position with a visceral feel that is uncanny. Everything in the cockpit moves and operates exactly as it does in the real B-17G.

All of these features and much more await you in the A2A Accu-Sim B-17. This is not a generic “B-17”, and this simulation is not like any other you have ever experienced before. Great care has been taken by A2A to replicate the actual “G” model of this airplane. It is historically accurate down to the rivets, instruments, handles, controls, cables, wires and tubes of the B-17G. Nothing has been left out and everything moves and operates authentically. A2A’s exclusive and proprietary Accu-Sim matrix provides features and controls far beyond that which FSX normally allows. That is why A2A has been able to create the most accurate, historically correct and complete simulation of the B-17G ever offered.

Mitchell Glicksman

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## **Chapter 1: Welcome**

### **About This Manual**

While much of the information in this manual is basic to many of our readers, we assume that the reader has no knowledge of combustion engine theory. This manual is for *everyone*, and uses colorful illustrations to teach the basics. The Accu-Sim system, however, is not basic, but is programmed with advanced physics which the professional pilot will appreciate. If you are an advanced pilot, you can likely just briefly skim over the contents of this manual; however, if you are eager to learn a bit about how a great big radial engine works, welcome and read on.

### **Installation**

Once your A2A Simulations Flying Fortress is installed, run the Flying Fortress Accu-Sim expansion pack installer and follow on screen prompts. The installer should find both Flight Simulator X and the A2A Simulations Flying Fortress automatically. If not, it will ask you to BROWSE for the correct location. Keep in mind, if Microsoft Flight Simulator X is properly installed, the Accu-Sim installation should be simple and straightforward.

Refer to Your A2A Simulations Flying Fortress Pilot's Manual

Included with your A2A Simulations Flying Fortress is a detailed pilot's manual. The Accu-Sim upgrade is built into this product from the ground up, so refer to your pilot's manual for specific systems operation and limitations.

## Designer's Notes

Any American, or ally of America, should be proud of what the United States created in the late 1930's / early 1940's with the Boeing B-17 Flying Fortress. The B-17's brought the war to the Germans, yet their crews paid a terrible price. But one thing is almost assumed from almost every wartime B-17 pilot is, they love this airplane. Why? Well, there are many reasons, but one has to be that it was designed and built with pride.

During development, and as we were digging into the pilots manuals, maintenance manuals, visiting the aircraft, speaking to those who fly and care for it, and all the rest that goes with researching an Accu-Sim aircraft, we began to truly realize just what a marvel this aircraft was (and still is). Now, after a year of studying every aspect of what makes this aircraft what it is, I stand here with both humility and awe. An aircraft like the Boeing B-17 does not come into existence without one very important quality, heart.

B-17 engineers attacked, head on, one of the most challenging aspects of flight and one of the major issues any air force faced in World War II; how do you take an inexperienced pilot and place him in a cutting edge piece of machinery, like the B-17, and expect him to not only survive, but perform to the best of his abilities? Quite simply, in most WWII-era aircraft, the pilot had to use extreme caution not to over-boost an engine at low altitudes or over-boost the turbo system and high altitudes. The pilot was constantly having to ride the edge while having to deal with fighting an enemy that is trying to kill him. In the heat of combat, the pilot was trained to keep a portion of his brain attached to engine management. Our existing P-47 Thunderbolt customers know how sensitive a large super-turbocharged radial engine can be. One inch of movement on the turbo boost lever can be the difference between a textbook takeoff or a smoking engine. A damaged engine over enemy territory basically means a very expensive airplane and trained pilot is lost.

Well the United States military saw this difficulty as a problem for the flood of young and relatively inexperienced pilots placed in these B-17's and thrown into harm's way. By the time the G model came out, they had designed in a solution that boiled down to a single rotary knob, the *Manifold Pressure Selector* (also known as the Turbo Boost Control).

The knob is deceptively simple. Turning this knob, controls four independent systems (remember, these are not clever computer chips, these are actual analog, physical devices – just brilliant creations). The pilot simply turns this knob to a preset position for **TAKEOFF**, **CLIMB**, or **CRUISE**, and the B-17 will manage the engine power for you. For example, for takeoff, if you have 100 octane fuel loaded, the pilot would select 8 on this dial. This will give him a maximum of 46" of manifold pressure at full throttle. The pilot could just advance the throttle to the stops and leave it there. Once in the air, a setting of 5 or 6 would be used for climb and the B17 will keep manifold pressures steady all the way to and past 30,000 feet. Once at cruising altitude, a setting of 4 or 5 would maintain a constant power.

With our latest, 4<sup>th</sup> generation of Accu-Sim, we have re-created this system for you, along with so many other wonderful things. We have included a fully functional maintenance hangar where your crew chief will give you written reports. He can repair or replace many parts, even change your oil filters, and you can see details down to each individual cylinder. A new physics engine allows for finicky engine starts to cracking open a window just slightly to wide opened, and to hear and feel the air rushing in. The electrical system now incorporates real world physics that will change the way you operate everything from your batteries, to generators, to flaps, gear, lights, and even your starters. Finally, after managing your engines for many flights, you can exercise your authority as pilot in command and instruct your co-pilot to manage the cowl flaps, intercooler flaps, and even the RPM levers. Essentially, this plane will become as easy to fly as a great big Piper J-3 cub. This is real; the way it was and still is to fly this timeless, amazing piece of American history.

However, the bottom line to any simulation is the ability for you, the pilot, to load up a simulation on your computer and everything you see, hear, and can touch, acts as you would expect it too. This is immersion. This is you, the pilot, stepping outside of this world and into an amazing new world where dreams come true. In this case, you will be flying a real B-17 Flying Fortress. Through sound, sights, and things we know to be real, Accu-Sim brings aircraft to life.

There is so much more to discover in this latest generation of Accu-Sim, that you will be busy and entertained for not just months, but years to come because with Accu-Sim, one thing is for certain – no two flights are the same.

Lastly, this product would not be what it is without the amazing people behind the scenes. This includes so many people from Rob, our lead artist, to the beta testers, to the most important group of all, our passionate customers. This aircraft is from those, for those who are passionate about every aspect of aviation.

Welcome to the world of Accu-Sim.

Scott Gentile  
Accu-Sim Project Manager



## The A2A Simulations Flying Fortress Accu-Sim Expansion Pack Features



- **Brand new Maintenance Hangar**

- Written crew chief inspection reports
- New engine diagnostics allow you to look inside the engine at individual cylinders and accessories
- Your mechanic can change oil, fuel and air filters for you
- Tires can wear and even blow
- Physical oil, fuel, hydraulic fluid, and even glycol systems work and are managed by your maintenance crew
- Your mechanics can repair turbos, superchargers, starters, generators, magnetos, carburetors, and even tighten down intakes

- **Accu-Physics**

- Sound and physics seamlessly fused together. Gradually crack open a window and hear / feel the wind as it enters the cabin
- Big radial engine start ups. With all cylinders modeled, starting an engine results in realistic sputters, kicks, coughs, and an engine that builds momentum to eventually fire up with a nice big BROOOOOM!
- Manage an electric system that has 4-8X the capacity of the average three-bedroom house. Lights, gear, flaps, bomb bay doors, turbos, fuel pumps, radios, etc. all rely on engine generators, batteries, and an on-board APU installed in the rear. Even surges occur when large motors like the flaps are run. Listen and see how all these systems operate together.
- Front pilots panel mounted on shocks. You can see engine's subtle (and not so subtle) vibrations, that shake the airframe.



- **Crew Assistance**

- Order your co-pilot to manage your engines
- Bombardier opens and closes bomb bay doors from the nose
- Radio man scans the skies for interesting broadcasts
- Waist gunners watch the flaps and can even be ordered to start or stop the on board APU
- Tail gunner lets you know when the tail wheel is up or down
- Order the crew to hand crank landing gear or flaps

- New internal cockpit lighting system includes fluorescent lights and glow-in-the-dark radiant gauges
- Real-time fuel management including fuel transfer pump and gravity-fed Tokyo Tanks for long range
- Two fuel grades (100 / 91 octane) and three oil grades available for proper cold and hot weather operations
- 3D model upgraded to Wings of POWER III standards with crisp, new modeling and texturing for stunning visuals

- **Fourth Generation Accu-Sim lives and breathes under the hood**

- 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. Now the gauges look beneath the skin of your aircraft and show you what Accu-Sim is all about.
- Airflow, density, and it's temperature not only affect the way your aircraft flies, but how the internal systems operate.
- Real-world conditions affect system conditions, including engine temperatures and authentic cowl flap management.
- Use intercooler flaps to cool Carburetor Air Temperatures (CAT), as high temperatures can adversely affect engine performance while low temperatures can lead to carburetor icing.
- Spark plugs can clog and eventually foul if the engine is allowed to idle too low for too long. Throttling up an engine with oil-soaked spark plugs can help clear them out and smoke will pour out of exhausts as oil is burned off.

- Overheating can cause scoring of cylinder head walls which could ultimately lead to failure if warnings are ignored and overly abused.
- On hot summer days, you will need to pay very close attention to your systems, possibly expediting your takeoff to avoid overheating due to radiant ground heat.
- Latest generation Accu-Sound now allows for a direct connection to the Accu-Sim and FSX physics engine with airflow through the airframe, windows, structural creaks, bumps, jolts etc. with over 500 sounds in all.
- Engine vibrations travel through the airframe. Front pilots panel is mounted on 6 shock mounts.
- Authentic component drag. Drop your gear, deploy your flaps, or just try a dive, and listen to your airframe. It's all there and it's all real.
- System failures. For example, if you deploy your flaps at too high of a speed, you will likely hear the flap motor stressing against the forces. Using bad habits like this can lead to a shorter life of components.
- Total audible cockpit made with recordings from the actual aircraft. Before you fly, enjoy clicking everything.
- Primer system modeled. Accu-Sim monitors the amount of fuel injected and its effectiveness to start the engine. Roughly 2-4 shots needed in hot weather and 4-8 in cold weather.
- Authentic battery. The battery capacity is based on temperature. The major draw comes from engine starting.
- Oil pressure system is affected by oil viscosity (oil thickness). Oil viscosity is affected by oil temp and oil dilution level. Now when you start the engine, you need to be careful and not raise RPM too much until oil temp is high enough to give proper oil pressure. If you raise RPM too high on a cold engine, especially very cold, oil pressure can raise to over 150psi. Oil pump failure can result. Also, extended inverted flight (negative g) can uncover the oil sump and reduce oil pressure. Do not fly in a negative g situation for more than 5 seconds.
- Oxygen starvation (hypoxia) is modeled. Just take off and climb without oxygen to see.
- Experience realistic startups with an authentic inertia starter. Wind it up and engage.
- Authentic engine sounds. When possible, we visit and fly the actual aircraft, capturing every area that makes sounds, namely the engine and how it not only sounds inside and outside, but based on where you are outside. We also have sounds to indicate how your engine is performing. For example, it may cough if the cylinders start getting fouled, or you may hear components start knocking when pushed too hard. This all contributes to you, the pilot, knowing your aircraft and how to read how it is functioning throughout every flight.

## **Chapter 2: Quick Start Guide**

Chances are, if you are reading this manual, you have properly installed the A2A Wings of Power II Accu-Sim Expansion Pack. 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 Wings of Power II Accu-Sim Expansion Pack requires the following to run:

**REQUIRES LICENSED COPY OF MICROSOFT FLIGHT SIMULATOR X**

**SERVICE PACK 2 (SP2) REQUIRED**

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

### **OPERATING SYSTEM:**

Windows XP SP2, Windows Vista, Windows 7

### **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**

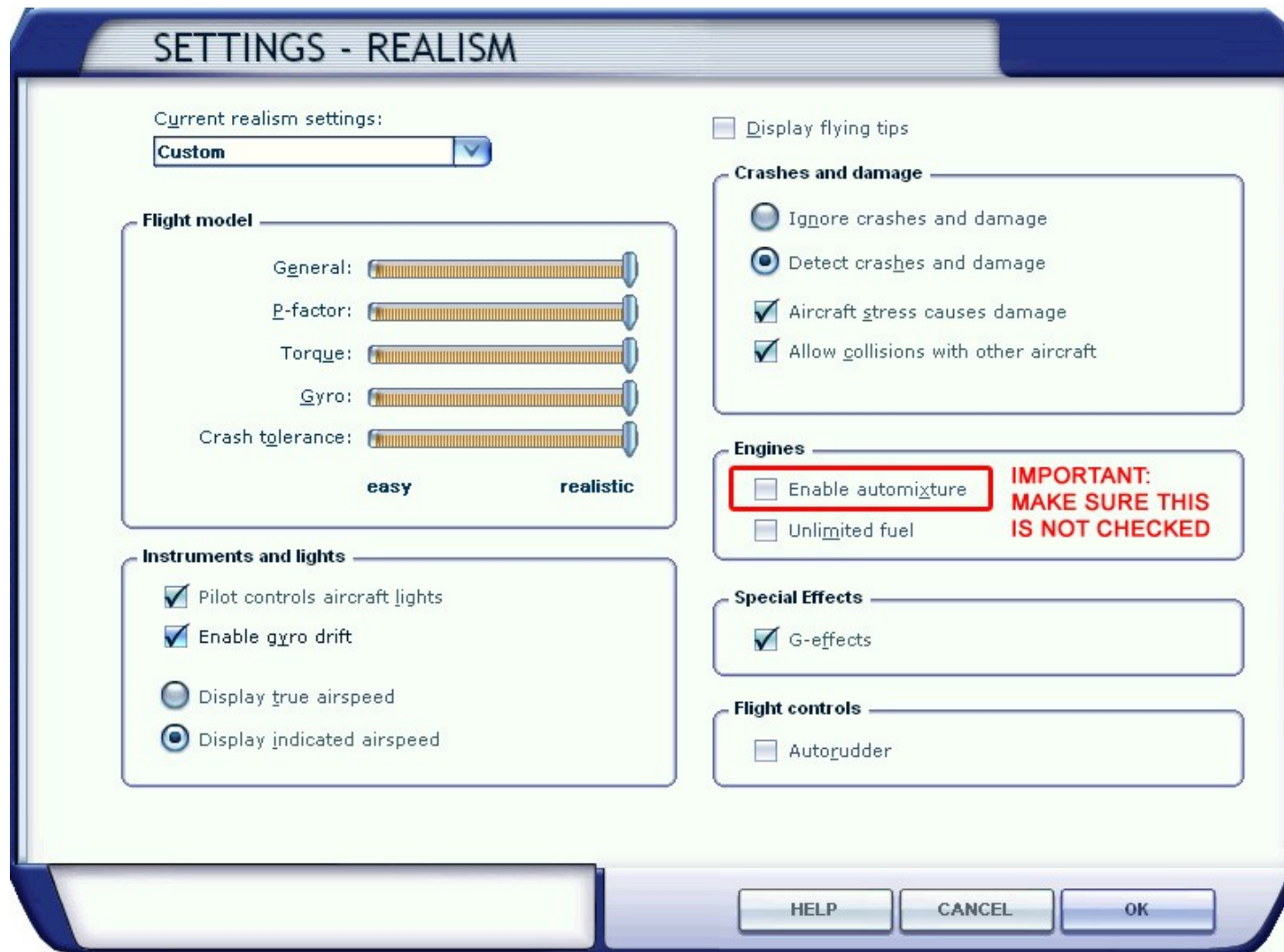
Included in your downloaded zipped (.zip) file, which you should have been given a link to download after purchase, is an executable (.exe) file which, when accessed, contains the automatic installer for the software.

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

## Realism Settings

The A2A Wings of Power II Accu-Sim Expansion Pack was built to a very high degree of realism and accuracy. Because of this, it was developed using the highest realism settings available in Microsoft Flight Simulator X.

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



### *FLIGHT MODEL*

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

### *INSTRUMENTS AND LIGHTS*

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

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

### *ENGINES*

Ensure “Enable auto mixture” is NOT checked. The Accu-Sim B17 has a fully working automatic mixture controls and this will interfere with our extensively documented and modeled mixture system.

### *FLIGHT CONTROLS*

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

## **Chapter 3: Accu-Sim and the Combustion Engine**



### **The Combustion Engine**

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 drive shaft, 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.

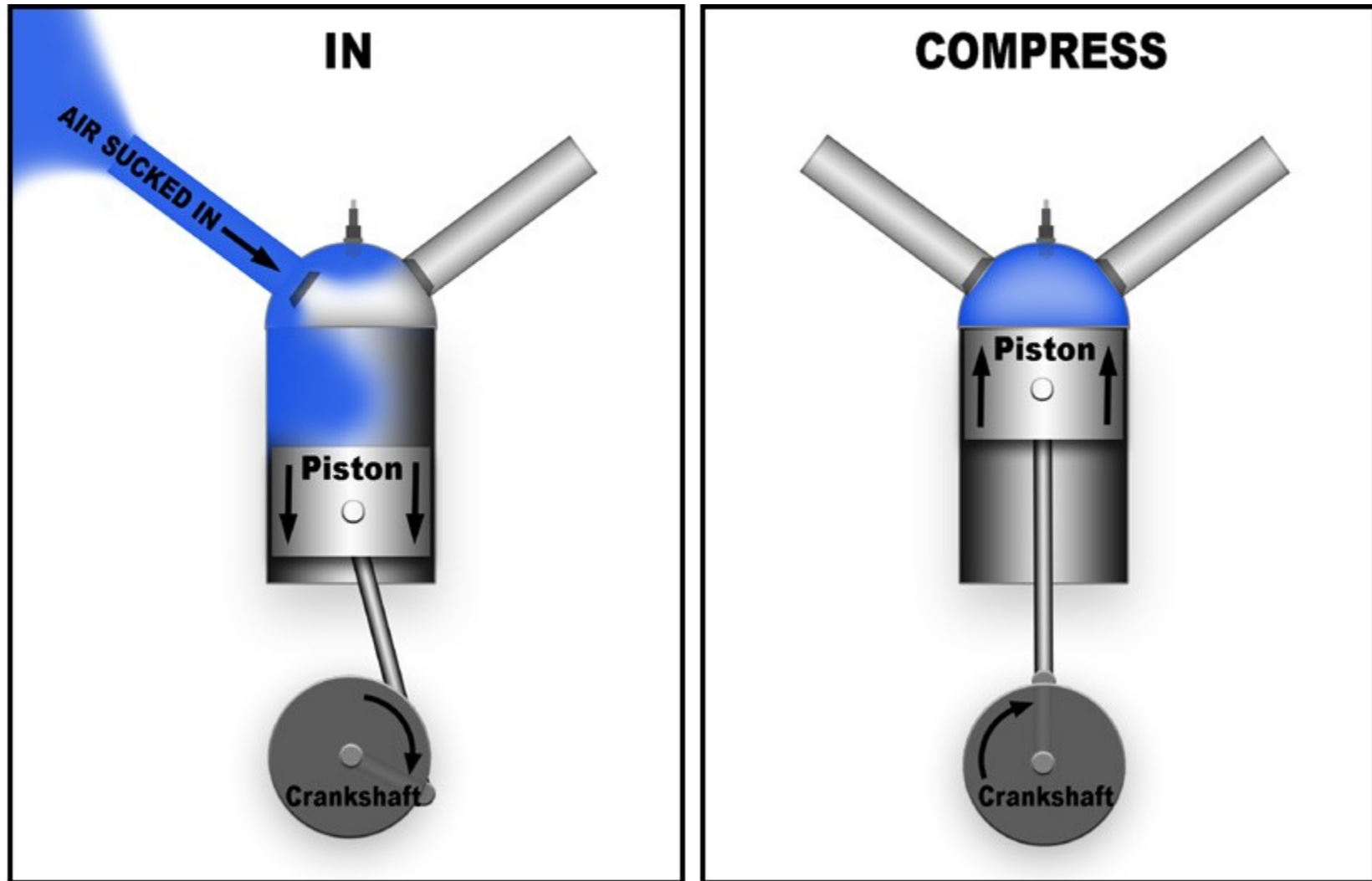
The main difference between an engine designed for an automobile and one designed for an aircraft is the aircraft engine will have to produce power up high where the air is thin. To function better in that high, thin air, a supercharger can be installed to push more air into the engine.

### **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.

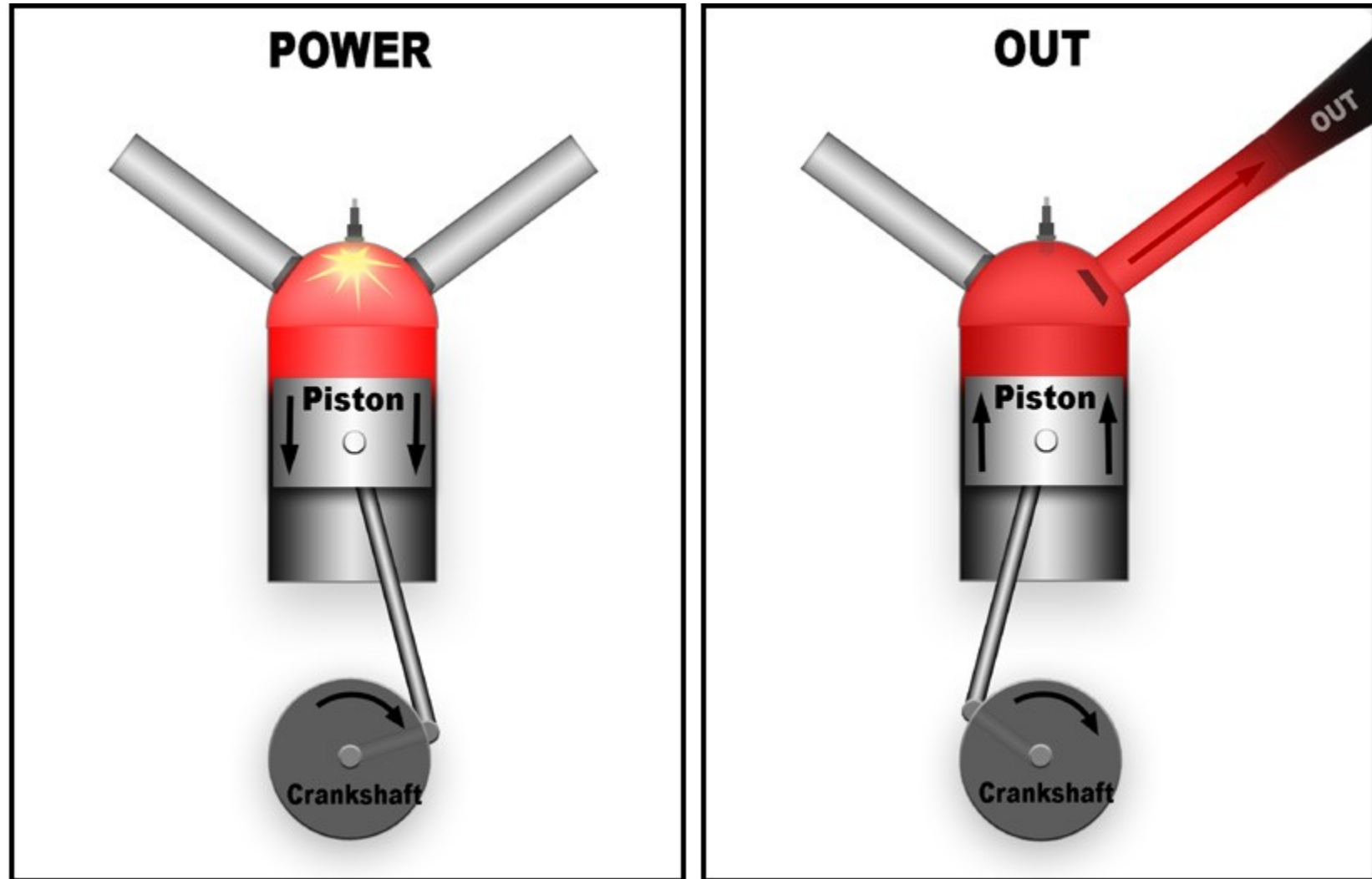
Look at the four pictures below and you will understand basically how an engine operates.

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



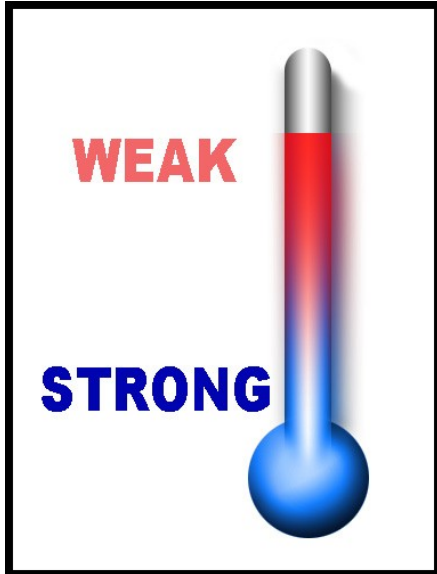


The spark plug ignites the compressed air / fuel mixture, driving the piston down (power), then on its way back up, the burned mixture is forced out the exhaust.



## Air Temperature

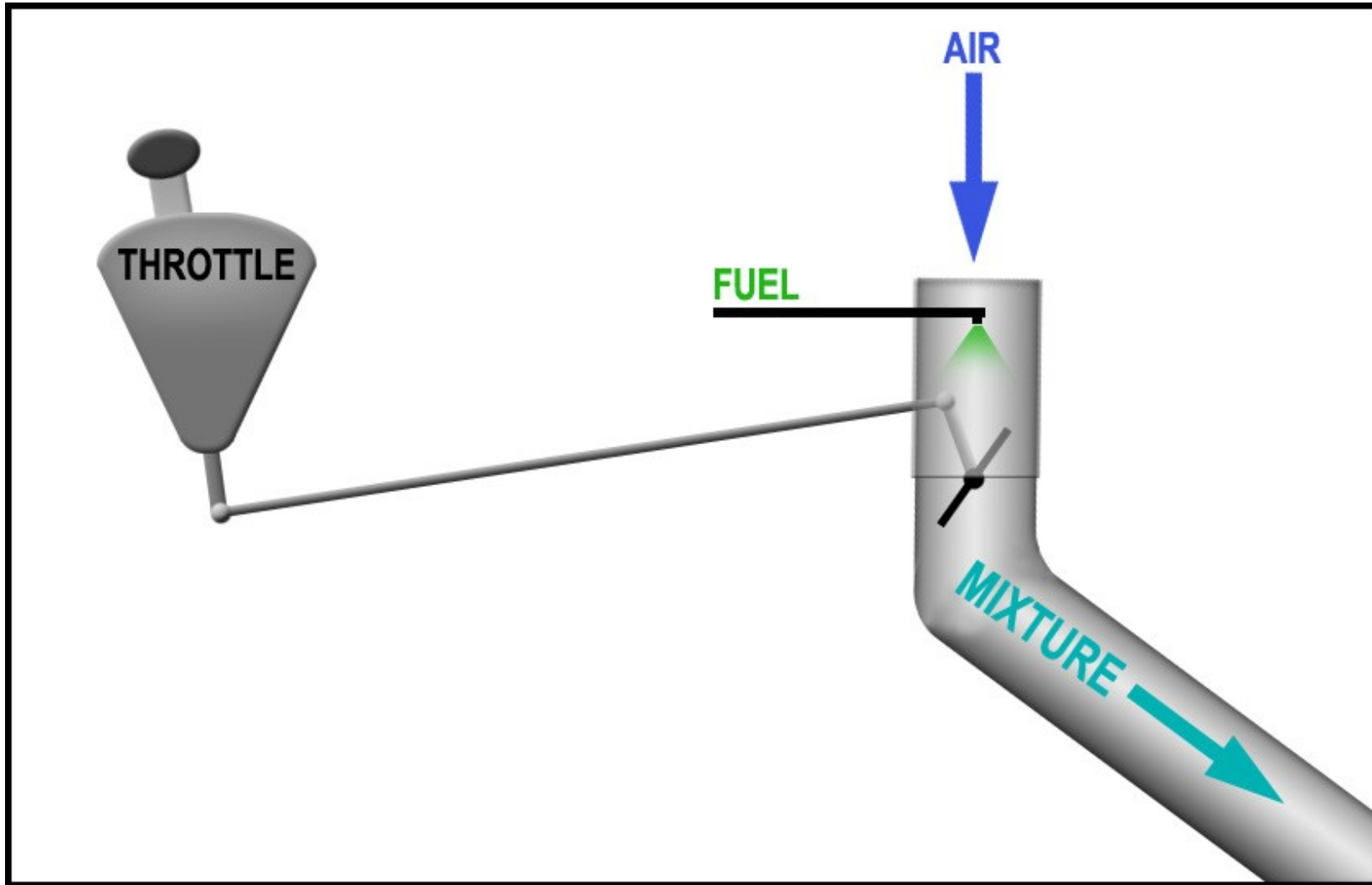
Have you ever noticed that your car engine runs smoother and stronger in the cold weather? This is because cold air is denser than hot air and has more oxygen. Hotter air means less power.



**Carburetor Air Temperature (CAT).** Your CAT is the temperature of the air just before it enters the engine. On the B-17, air enters a port on the leading edge of the wing, gets compressed by a turbo fan, is cooled by an intercooler, and is finally mixed with fuel and enters the engine. Use your intercooler flaps to control this temperature.

## Mixture

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



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

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

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

However, since the engine at high power will be nearing its maximum acceptable temperature, you would use your best power mixture (0.08%) when you need power (takeoff, climbing), and your best economy mixture (0.0625%) when throttled back in a cruise when engine temperatures are low.

So, think of it this way:

For HIGH POWER, use a RICH mixture.

For LOW POWER, use a LEAN mixture.

### The Mixture Lever

Most piston aircraft have a mixture lever in the cockpit that the pilot can operate. Forward is usually rich, and backward is usually lean (NOTE: The reverse is true in the B-17). 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.

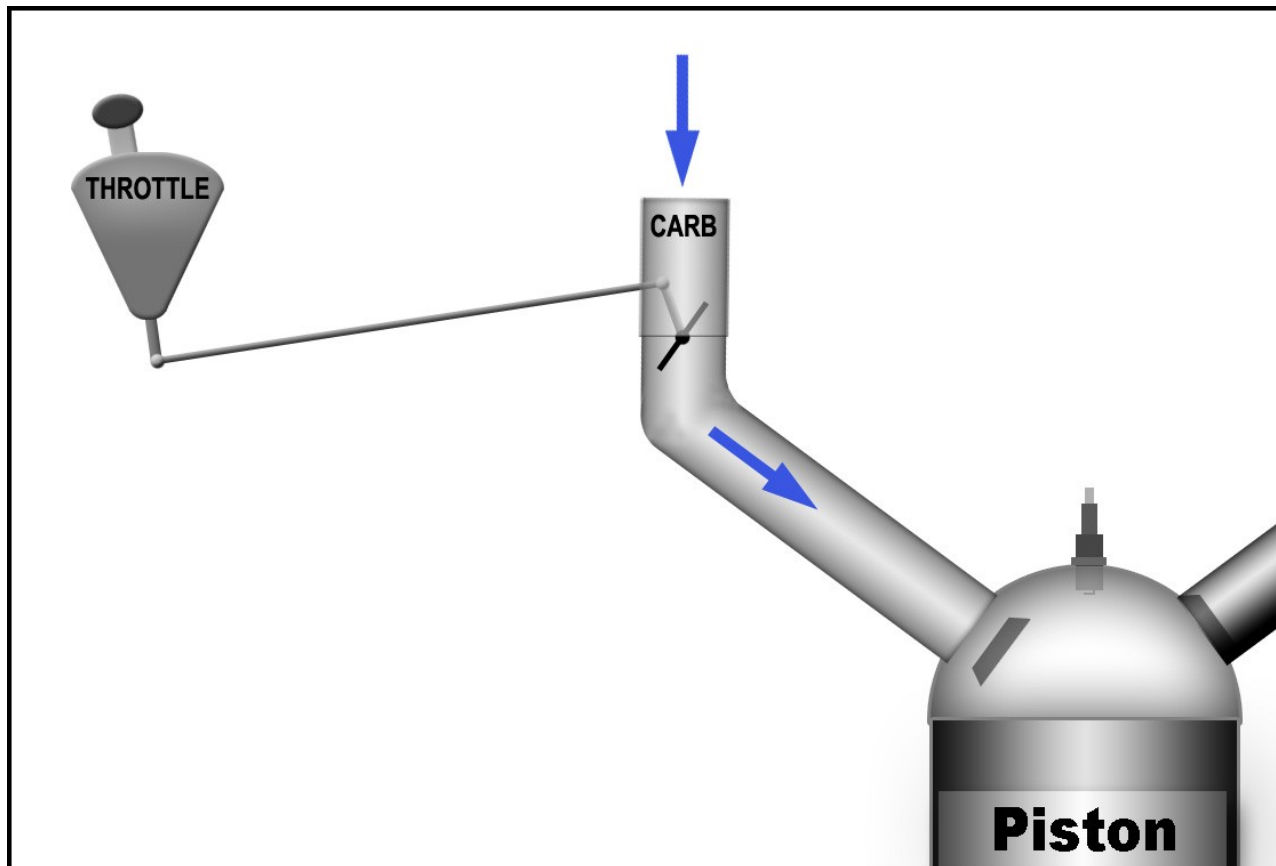
### **AUTO-RICH AND AUTO-LEAN**

More advanced aircraft may have an **AUTO-MIXTURE** system, with **AUTO-RICH** and **AUTO-LEAN** settings. You simply select which one you want and the auto-mixture system automatically adjusts the mixture for you based on altitude and power setting.

## 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. For the most part, you will be 'throttling' your motor, meaning *you* will be dictating where it's limit is.



## 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 29.92Hg **BAROMETRIC PRESSURE**. To keep things simple, let's say 30Hg 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 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 vacuum.

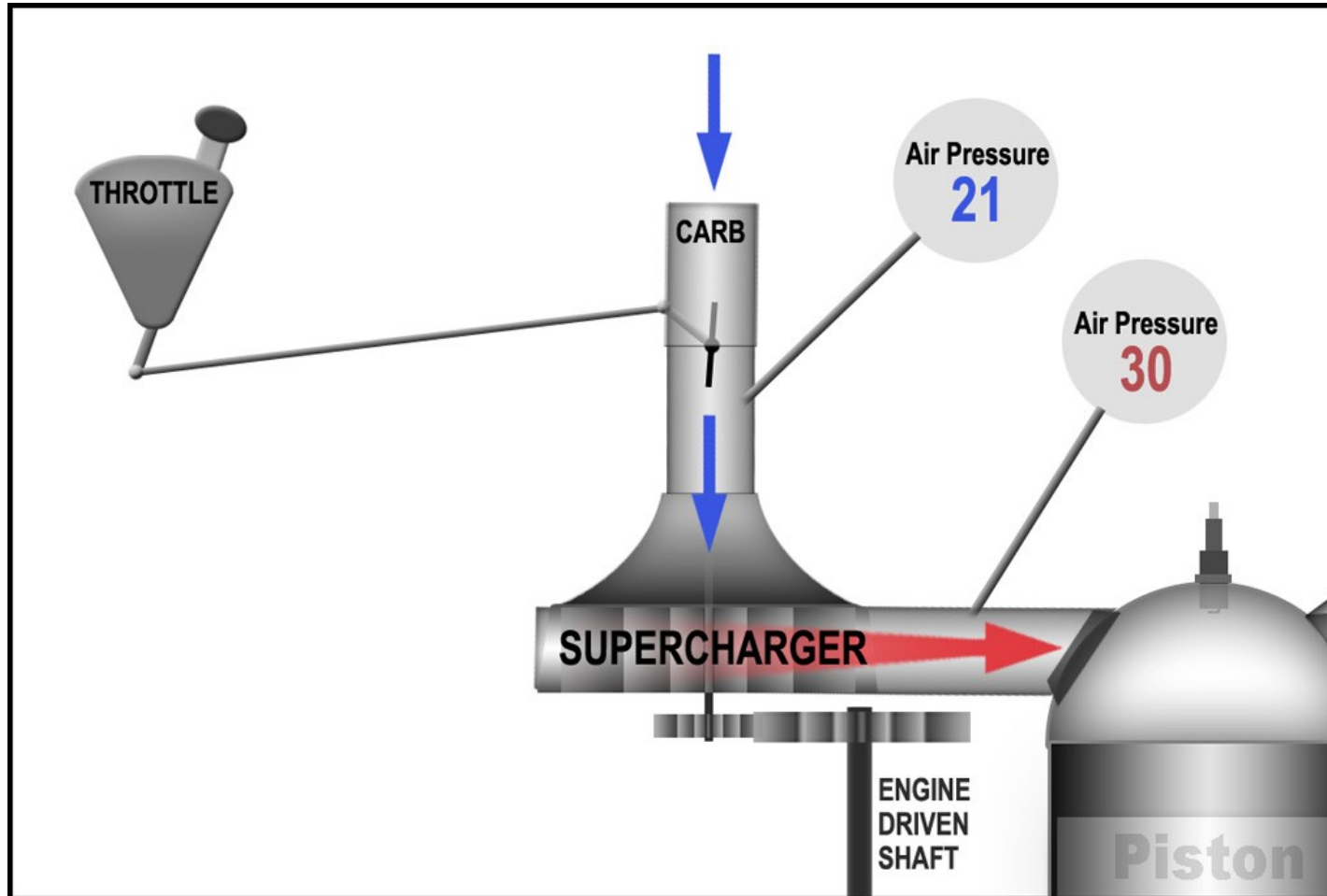
As you increase power, you will notice your manifold pressure comes up. This is simply because you have used your throttle to open those throttle plates more, and the engine is able to get the air it wants. If you apply full power on a normal engine, that pressure will ultimately reach about the same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

### *So how can an engine produce more power at high altitudes where the air is so thin?*

Since the power an engine can produce is directly associated with the pressure of the air it can take, at some point during your climb (above 10,000 feet or so), that engine will be producing so little power that the aircraft can no longer climb. This is the point where the engine can barely sustain level flight, and is considered the aircraft's service ceiling. A supercharger can raise this ceiling.

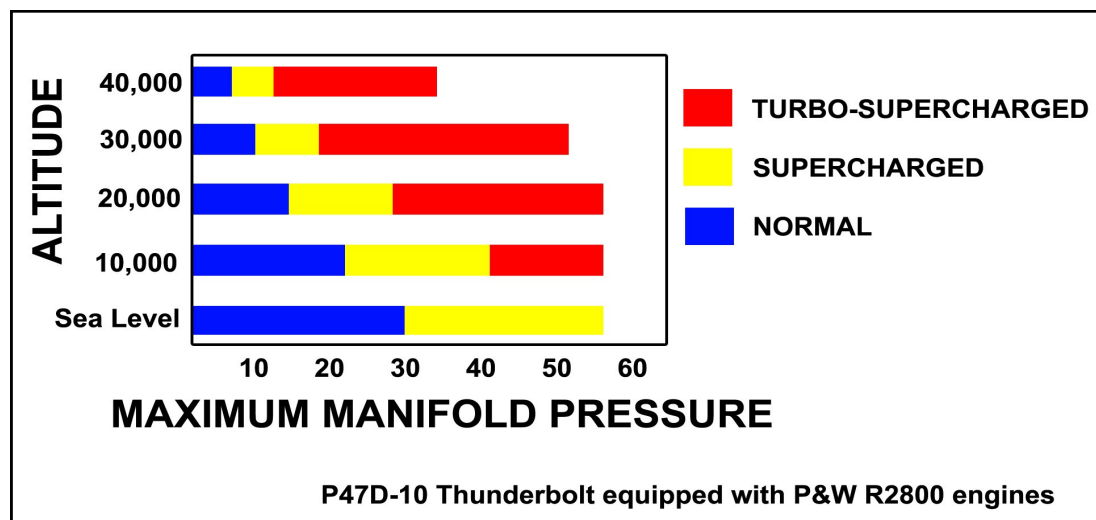
## Supercharging

The supercharger has a powerful fan installed in your intake system that forces *more* air into the engine. As you fly higher and the air pressure decreases, your supercharger will help to compensate and keep air pressure higher than it would be otherwise.



Let's say while air pressure at sea level is 30", it is 21" at 10,000. At 10,000 feet, your supercharger fan pushes in more air to increase your manifold pressure to 30". Now your engine will produce the same power at 10,000 feet as it would at sea level. It would feel every bit as strong as it did when you took off.

However, even a supercharger has its limitations. At some point, it will hit it's own limit of how much air it can force and manifold pressure will again start to drop off. Some aircraft include a second stage supercharger, this is basically a HIGH / LOW gear. Some planes may automatically kick into HIGH at a certain altitude. When you hit this altitude, you will notice a nice punch of power. Other planes, like the B-17 Flying Fortress, use both a turbocharger and a supercharger. A turbocharger does the exact same thing as a supercharger, except while a supercharger is driven directly off the engine by mechanical gears, a turbocharger is driven by the power of the exhaust pressure. This is where the term 'turbo lag' comes from. Turbo lag is the time delay after you apply power and before the exhaust has enough pressure to spin the turbo charger hard enough to push more air into your engine. The turbo, being driven off exhaust, is only applying power when the engine is *producing* power. So the turbo process is a cycle – engine power produces more turbo power that produces more engine power and so on. It's like rolling a snowball down a hill, this is your turbo 'spooling' up. Since the supercharger is gear driven, it moves perfectly in step with engine RPM – it's there and ready when you apply throttle.

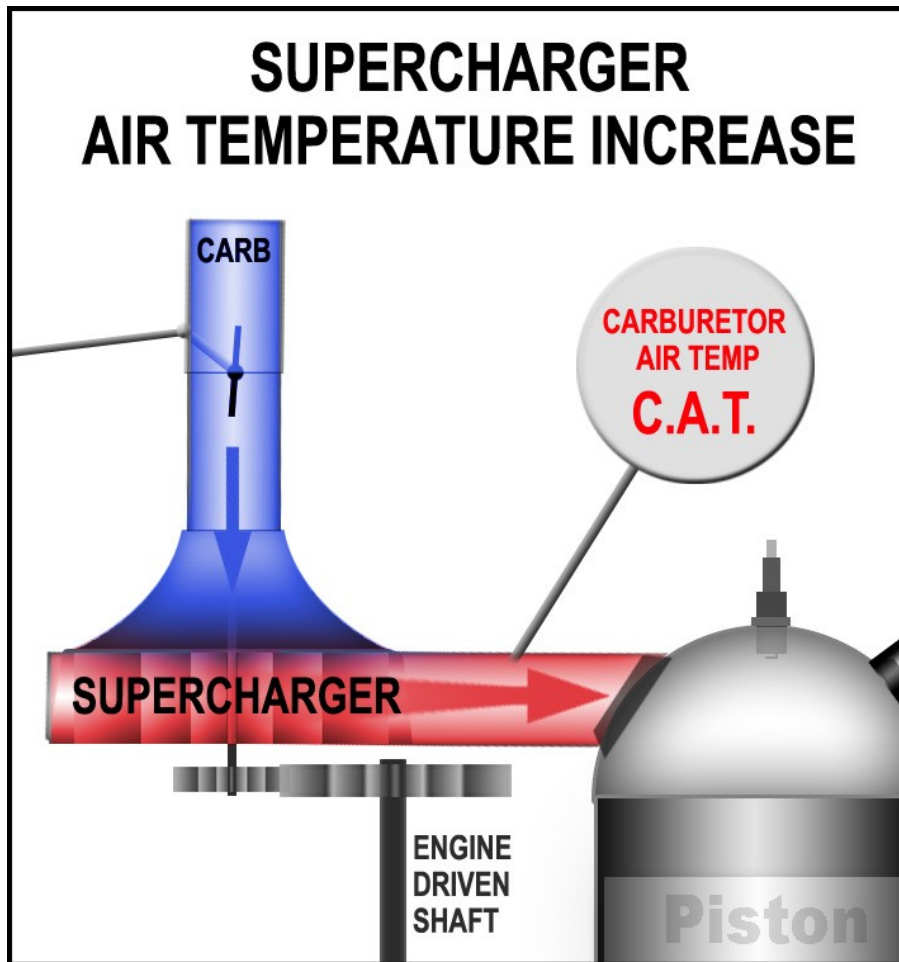


While turbo and superchargers can be used to compensate for lost air pressure up high, they can also be used to *over-boost* the power at sea level. This is called "ground boosting." Ground boosting adds more air pressure (and power) at sea level than would normally be available.

If you add power and see your manifold pressure rise above 30", then you have some form of supercharging or turbocharging adding more air into the engine than would normally be available. A normal engine that is producing 1,000 horsepower at 30" will produce 2,000 horsepower at 60", since it is twice the pressure. 45" produces 1,500 horsepower and so on.



## Supercharging heats the air



The downside to supercharging is heat. The more you compress air, the more the temperature increases, therefore more supercharging = higher CAT temperatures. The increase in temperature can be extreme. -40 degree air coming into the intake system can be 100 degrees hotter after it exits the supercharger. This is where your **INTERCOOLER** comes into play. The **INTERCOOLER** is a heat exchange, and is basically a radiator taking heat out of the incoming air. Use your **INTERCOOLER FLAPS** to transfer heat out of your intake manifold and out the flap doors. The more you open your intercooler flaps, the more heat you remove. Use your intercooler flaps to keep CAT temps nice and low for a strong and healthy running engine.

## 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.

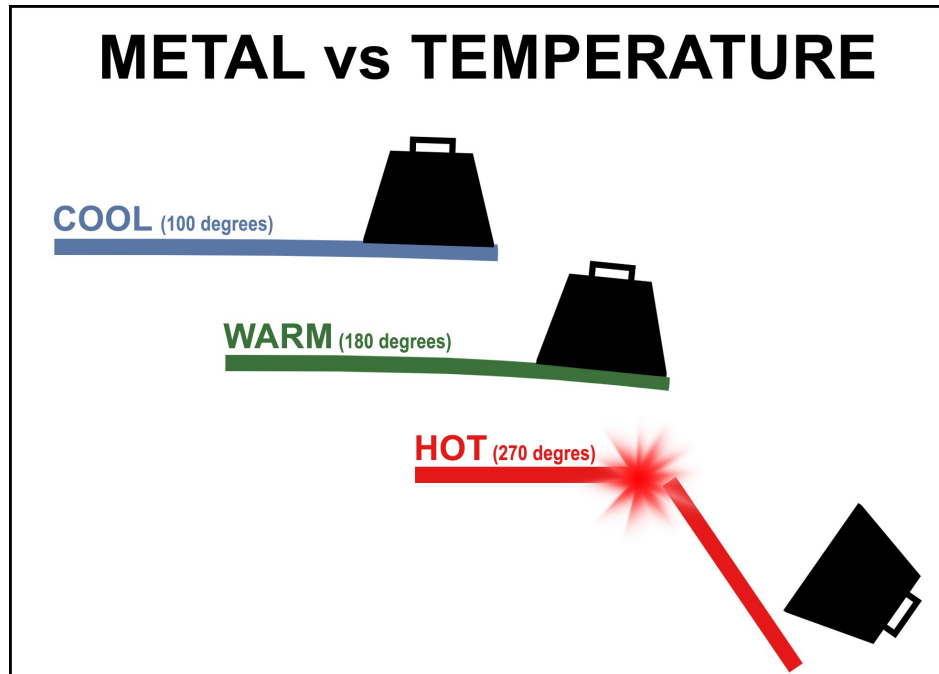
An added advantage to having two sparks instead of one is more sparks means a little more power. The pilot can select Ignition 1, Ignition 2, or BOTH by using the MAG switch. You can test that each ignition is working on the ground by selecting each one and watching your engine RPM. There will be a slight 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.

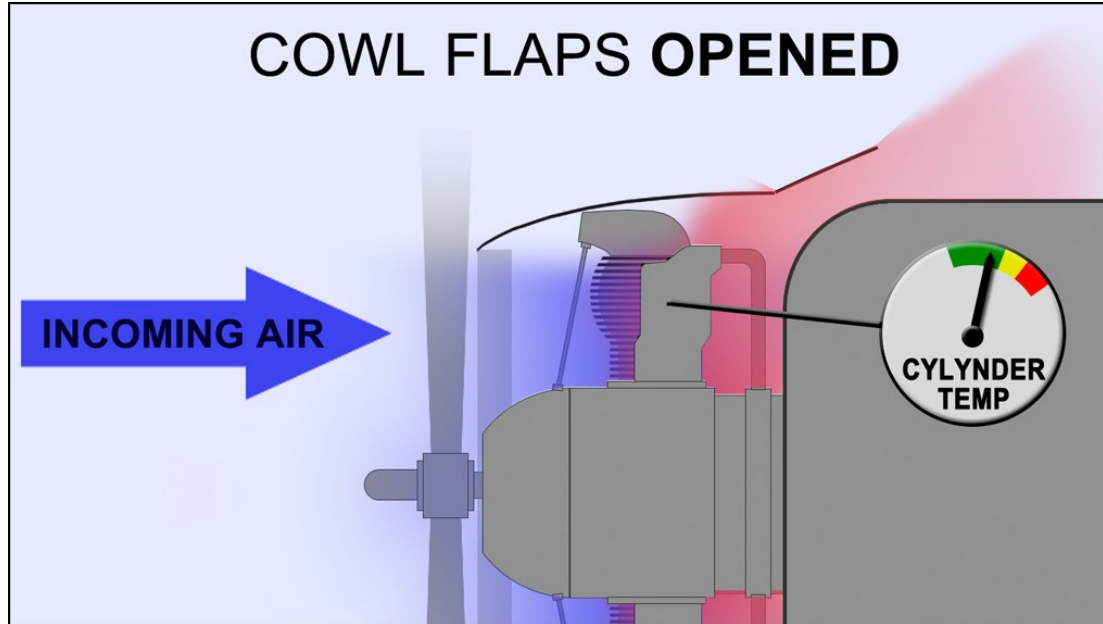
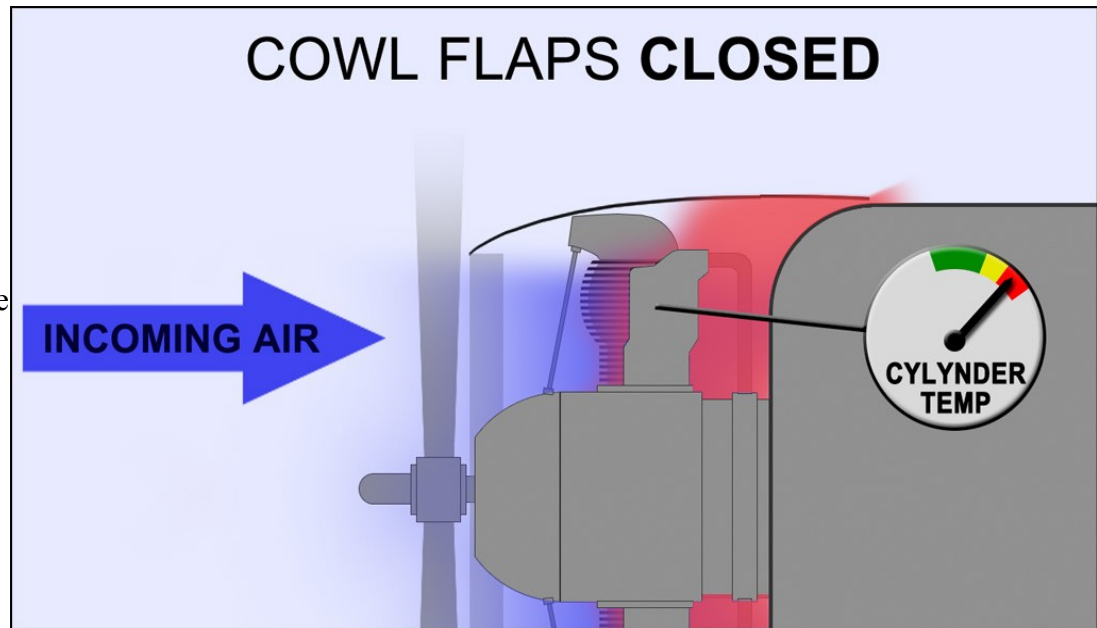
The hotter the metal, the weaker it's strength.



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

### CHT (Cylinder Head Temperature)

CHT is a measurement of the temperature in the back of the cylinder head. The combustion is happening right inside the cylinder head, so high power will increase temperature rapidly. The key is to watch and manage your cylinder head temperature by being aware of the outside air temp, keeping your speed up, and using your cowl flaps to control how much cooling is applied. The largest CHT rise will come from sitting on a hot ramp, just after takeoff, or in a slow and steep climb.

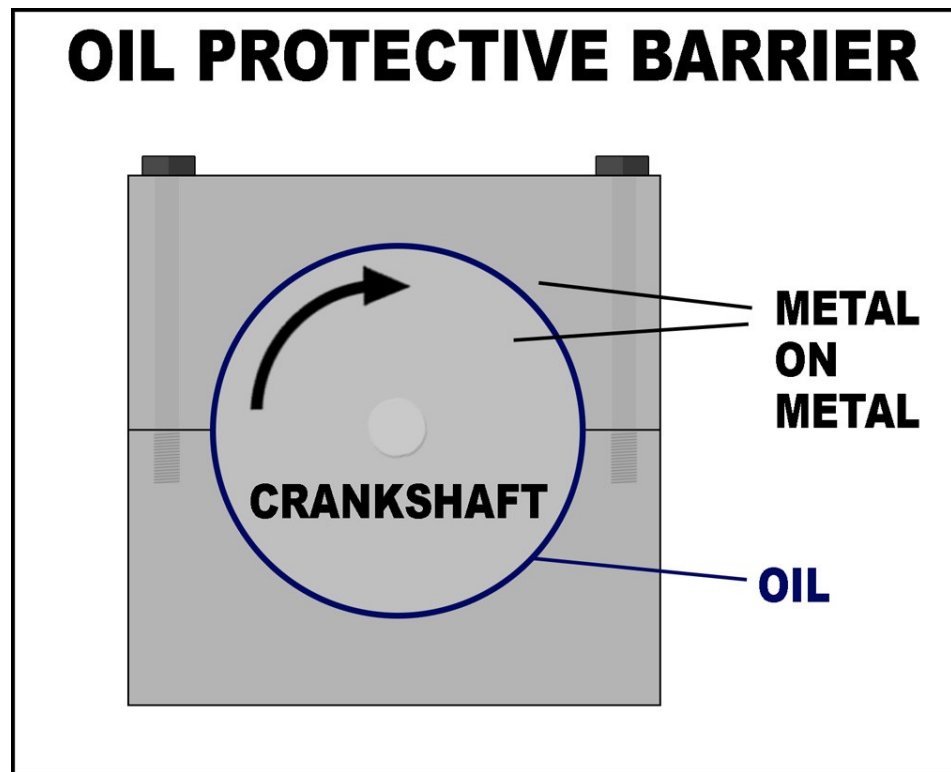


## Lubrication System (Oil)

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.

Below 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.

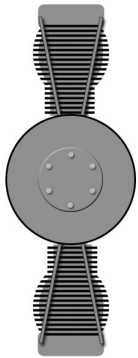


## More Cylinders, More Power

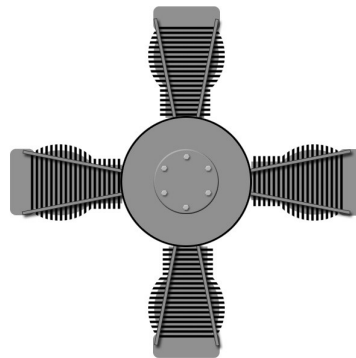
The very first combustion engines were just one or two cylinders. Then, as technology advanced, and the demand for more power increased, cylinders were made larger. Ultimately, they were not only made larger, but more were added to an engine.

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

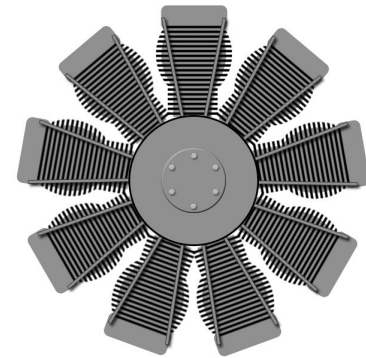
**2 Cylinders**



**4 Cylinders**



**9 Cylinders**

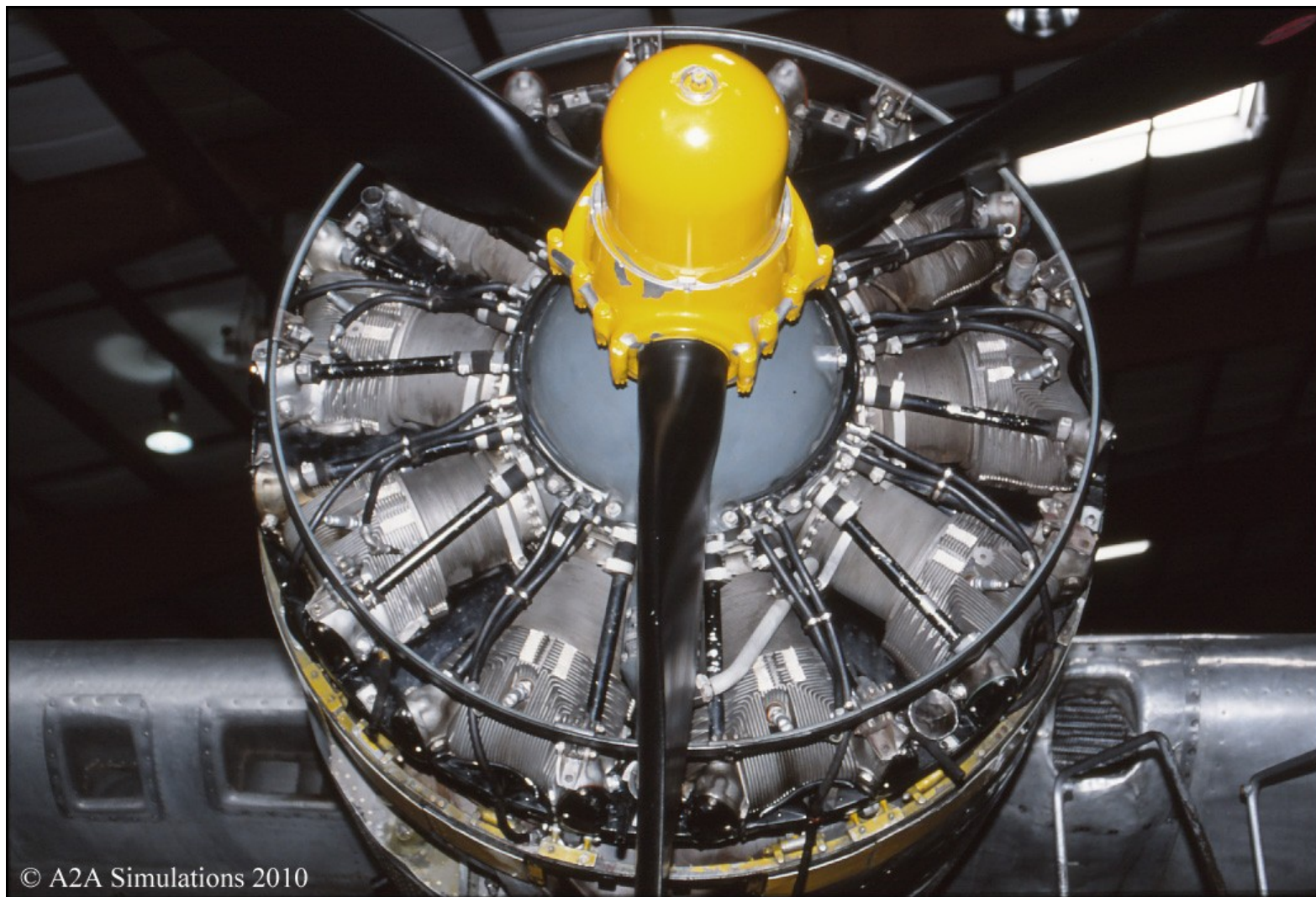


The more cylinders and cubic inches of combustion chambers added to an engine, the more heat it produces.



### The Wright R-1820 Cyclone

Here is the Wright 1820 Cyclone 9-cylinder engine under maintenance on the B-17G “Fuddy Duddy.” This photo was taken from one of our earlier B-17 research trips. Special thanks to B-17 crew chief, Ed Knitter, for sharing his experiences.



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## **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.



## Chapter 4: Accu-Sim and the B-17 Flying Fortress



Developed for:



## Accu-Sim Expansion Pack Overview

The Accu-Sim Expansion Pack upgrades core areas of Microsoft Flight Simulator X to provide the maximum amount of realism and immersion possible. Each pack is developed and tailored to a specific aircraft. Our fourth Accu-Sim pack has been created for our latest and greatest, A2A Simulations B-17 Flying Fortress aircraft.

## What is the philosophy behind Accu-Sim?

Real 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 real life. This is Accu-Sim.

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. Right from the very first Accu-Sim pack, we designed in the ability to turn the entire Accu-Sim system on or off with a single switch. We actually implemented this change because we felt only a small percentage of our customers would want this high level of realism and to our pleasant surprise, the vast majority opted to get the Accu-Sim pack and leave it on all the time, but this capability remains there for those who just want the option and control. However, if Accu-Sim is enabled and the needles are in the red, there will likely be consequences. It is no longer just an aircraft, it's a simulation.

## Actions lead to consequences

Your A2A Simulations Flying Fortress is a complete aircraft with full system modeling. However, flying an aircraft as large as the A2A Flying Fortress requires 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 run really poorly. 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 av-gas.

## **The Cockpit**

At the start of World War II, America had to put 20 year old green pilots in very complicated machines. The B17 cockpit, as a result of this effort, is one amazingly well-built and friendly “office.” From the position and color of warning lights to the starting sequence to intuitively labeled systems, this cockpit is designed to speak in clear, simple terms to the captain and his crew. One of the marvels of this system is the automatic manifold pressure system, which is covered later in this manual.

## **Your Crew**

Just like real life, some things you can predict, and others you cannot. You could be taxiing out on a newly serviced B-17, and for no reason at all, a hydraulic line can blow and ruin your day. Common sense piloting techniques and properly scheduled maintenance can and does go a long way to a reliable aircraft. When unpredictable things happen, a properly trained captain and crew can respond with calm, quick thinking. Your crew is there to help you. As the captain, offload some of your workload to your co-pilot, that is what he is there for. Listen to your waist gunners and tail gunners for the status of your landing flaps, main gear, and tail gear. Your radio man can even make long trips more enjoyable by scanning the skies for interesting broadcasts.

## **Your Aircraft Talks Too**

We have gone to great lengths to put in realistic sounds that will help you know how your aircraft is running. 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 a real pilot, you will get to know the sounds of your aircraft, from the tires scrubbing on landing to the stresses of the airframe to that window that may be just barely cracked open.

## **Be Prepared – Stay Out of Trouble**

The key to successfully operating your B-17 is to stay ahead of the curve, and on top of things. It's a complex but quite robust and tough aircraft. We have included for you, the pilot, a little “Pilot Notes” panel where you can manipulate things that in the real aircraft may be out of sight, such as the intercooler and cowl flaps.

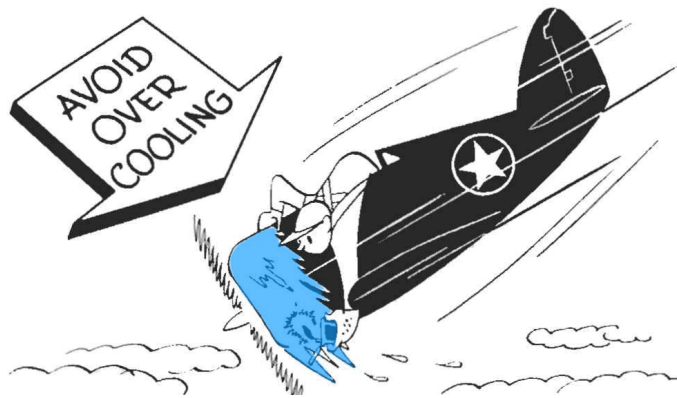
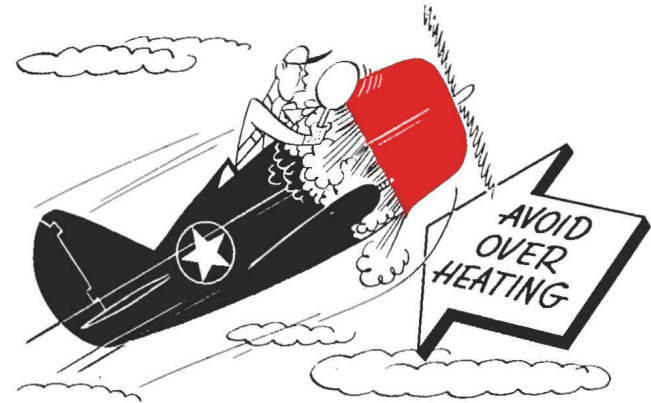
## Key Systems to Watch

### CHT (Cylinder Head Temperature)

This is a measurement of the actual cylinder heads in the engine. This temperature is quick to heat up and cool down (unlike your oil temperature which takes longer to change). This is your most critical area to watch. Running the engine too hot can quickly result in catastrophe. Never let these temps get above 260 degrees, as you not only risk engine damage but fire. THE MOST COMMON MISTAKE for a junior pilot is FORGETTING TO REDUCE POWER AFTER TAKEOFF. If you watch your CHT temp during takeoff, through your little 2D “Pilot's Notes”, you will see how fast the temperature rises when full power is applied. Make sure you do not begin your takeoff run with a hot engine (over 200 degrees) or you could be overheating the engine shortly after you lift off at the end of the runway.

Key things to keep CHT in check:

1. Open Cowl Flaps
2. Reduce power immediately after takeoff to climb power
3. Do not climb too steeply to ensure adequate airflow – keep speeds over 145mph



### Cylinder Head and Oil Temperature

Engine temperatures will rise based on the power, air temperature, and the air flow through the engine. Use common sense and make gradual adjustments with power and speed. Avoid high power, steep climbs, and low power descents with cowl flaps opened.

## Engine Health

Every time you load up your Accu-Sim B-17, you will be flying the continuation of the last aircraft. Things will sometimes be different, however. The gauges are never exactly the same. There are just too many moving parts, variables, changes, etc., that continuously alter their condition. Sometimes, however, your engine may be running too hot, or may just not be producing the same power. You will need to learn to keep an eye on that one engine until you get your plane on the ground so it can be looked at by maintenance.

NOTE: Signs of a damaged engine may be lower RPM, lower torque values, lower manifold pressure, or possibly hotter engine temperature.

## **Professional Audio Makes a World of Difference**

Microsoft Flight Simulator X, like any piece of software, has its limitations. Accu-Sim breaks this open in so many areas, one of which is the sound system. We use our own physics and full-featured sound engine to provide the most believable and immersive flying experience possible. The sound system is massive in this Accu-Sim Flying Fortress and includes engine sputter / spits, bumps and jolts, body creaks, engine detonation, runway thumps, gear doors and hydraulics, cowl flaps, intercooler flaps, oil flaps, inertia starting, dynamic touchdowns, authentic simulation of air including buffeting, shaking, windows, jammed flaps, broken gear, oxygen sounds, an array of electrical motors, crew hand cranking systems, 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.

## **Physical Gauges**

Each gauge has mechanics that allow it to work. Some gauges run off of engine suction, gyros, air pressure, or mechanical means. The suction gauges may fluctuate when starting the #2 motor and the magnetic compass, which is sitting in oil, will yaw to the side and may be moving back and forth so much you cannot read it until it settles, 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 needs these to be real.

## **Landings**

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.

## Batteries

Accu-Sim installs authentic batteries into a feature-rich electrical system, thanks to the help of our on-staff own electrical engineer and high time pilots. Just like a real battery, these batteries suffer from reduced capacity as they age, have a limited output (35 amp hours each for our B-17), can overheat if you demand too much load, and can even load up your entire system if you have a brand new, but dead battery on-line (ever try to jump start a car with a dead battery and nothing happens? Disconnect the dead battery and try again, since the dead battery is stealing all the electricity). Just like running water, electricity is no stranger to physics and with our latest version of Accu-Sim, you can see (and hear) the electricity flowing throughout the system.

In addition, weather affects a battery's performance in Accu-Sim, just like in real life. Fortunately, you can always order your ground crew to charge up your batteries if you suspect they may be heavily discharged, but, this is more or less a cheat, or something a well-cared for aircraft should not have to do. Use your batteries wisely, and they will last a long time.

## APU (Auxiliary Power Unit)

You have an on-board APU, which is basically a small engine generator located in the waist section of the aircraft. You can order your crew to start this generator at any time on the ground, or in flight. It is good practice to run the APU to start your engines. Then once the engines are running, turn the engine generators on then order your crew to turn the APU off once the main generators have taken over. To keep things in perspective, each engine generator can deliver 200 amps of consistent power at 1,800RPM (this is 800 amps with all four engines running), your APU can generate only 70 amps, and your batteries can deliver 35 amp hours (batteries are rated in AMP HOURS, which means, a brand new battery can deliver 35 amps for 1 hour before it is completely discharged).

Things to watch out for that draw a tremendous amount of current are:

- Landing lights (100 amps)
- Hydraulic pump (90 amps)
- Flaps motor (70 amps)
- Gear motor (70 amps)
- Bomb bay doors motor (50 amps)
- Electric fuel pumps (15 amps each)
- Fuel transfer pump (30 amps)

As you can see, just turning on your landing lights can overload your APU, so be mindful of each system you turn on.

## **Chapter 5: B-17G Flying Fortress Accu-Sim Pilot's Manual Addendum**

### **Quick Flying Tips**

- ★ **Keep your Crew Reports up** (SHIFT -2 ). They will provide you with helpful information.
- ★ **To Change Views** Press A or SHIFT + A.
- ★ **Open your cowl flaps when running the engine on the ground** or taxiing to ensure that they do not overheat. This is especially true on very hot days (80-100° F). You can open them with the switches on the quick 2D “Controls” panel using SHIFT-3.
- ★ **Keep engines at or above 1,000 RPM.** Failure to do so may cause spark plug fouling. If your plugs do foul, try running the engine (you will know by the fluctuating RPM displayed on the gauge) 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 will have to pull the aircraft into the maintenance hangar and have the crew manually clean the plugs.
- ★ **Avoid pivot turns.**
- ★ **Make sure engines are warm** (oil temp min 40 degrees) before applying full power.
- ★ **Use AUTO-RICH for TAKEOFF / CLIMB and AUTO-LEAN for CRUISE.** The aircraft features a fully automatic (and realistic) working mixture system. Simply drag the mixture control for each engine near the various mixture settings and it will “snap” into place.
- ★ **REDUCE POWER** after takeoff.
- ★ **Let your co-pilot manage your systems and relax** (CONTROLS-SHIFT-3). After all, you are the captain.
- ★ **POWER UP SEQUENCE:** Mixture, prop, throttles, turbochargers.
- ★ **POWER DOWN SEQUENCE:** Turbo, throttles, prop, mixture.
- ★ **Avoid high power at lower RPM**

- ★ **Carb-ice:** Increase turbo boost, lower throttle
- ★ **Over 10,000 feet:** Oxygen ON, air cleaners OFF
- ★ **Be careful with high-speed dives,** as you can lose control of your aircraft if you exceed the maximum allowable speed.
- ★ **For landings, take the time to line up and plan your approach.** Don't use landing gear or flaps as brakes. Keep your eye on the speed at all times.
- ★ On final approach, pump your brakes several times to trigger the hydraulic pump, which will give you full braking power on landing.
- ★ **Do not** lower flaps above 147mph, as this places stress on the flaps motor and the mechanical linkage.
- ★ **On landing, raise your flaps once you touch down to settle the aircraft,** pull back on the stick for additional elevator braking while you use your wheel brakes.
- ★ Using a Simulation Rate higher than 4X may cause odd system behavior.
- ★ The wind can get so loud in a B-17 cockpit, it can even drown out the engines. You can use your headphones (SHIFT-2) to reduce this wind noise which will allow you to hear the crew better.
- ★ If your radioman finds something on the radio, turn your channel switchbox (pilot left) to LIAISON.



## General Description

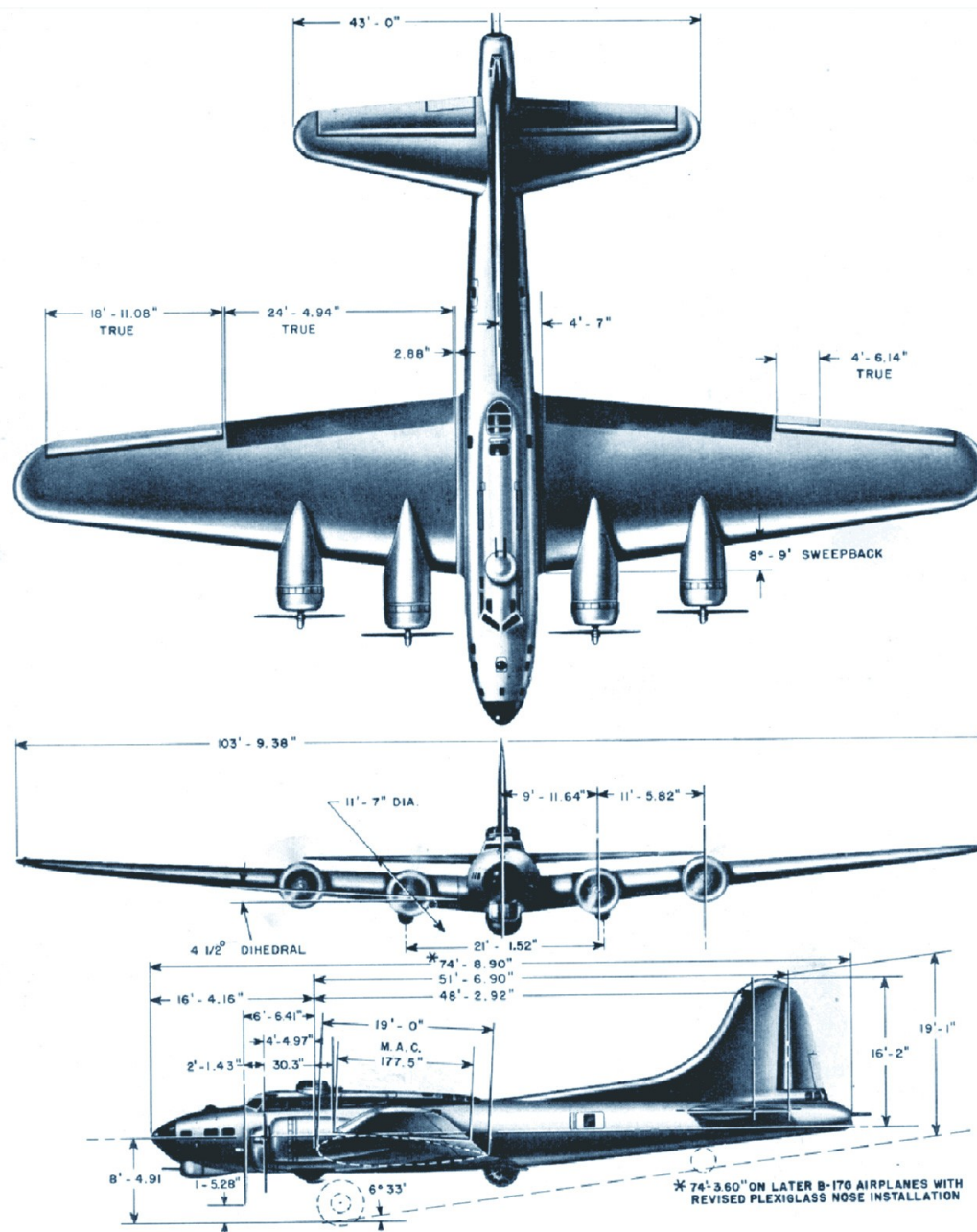
Without a doubt, the Boeing B-17 Flying Fortress is the most recognized and well-known aircraft to emerge from World War II. There are many reasons for this, not the least of which was an aggressive publicity campaign by the War Department, which resulted in the superb wartime classic propaganda film "Memphis Belle" (not to be confused with the modern film of the same name), and a year-long tour of the United States by the actual "Memphis Belle" and her crew.

But, despite the hype that was associated with this aircraft (Liberator crews sometimes groused about there being 11 crew members on every B-17, including a publicity officer), there were very solid reasons why the B-17 Flying Fortress holds a revered place in history and in the hearts of those who flew her. It was, first and foremost, a supremely functional and extremely rugged aircraft. No other aircraft to serve during WWII has come away with as many documented cases of surviving extreme battle damage and making it home. Designed during peacetime, the aircraft was not rushed to the drawing board and emerged as wonderful aircraft to fly. The Fortress was a very stable and forgiving aircraft, truly a "pilot's aircraft" in all respects, and was a pleasure to fly. It can be trimmed to fly hands-off for any normal flight regime and, while slow to maneuver, is quite responsive to the controls for such a large craft. While aerobatics are prohibited officially, there are many documented cases of B-17s being put into spins, rolls, stalls, and other acrobatics by instructors and pilots who flew the type. Pilots who flew all of the major American bombers of WWII -- the B-17, B-24, and B29 -- state almost universally that the B-17 was a joy to fly as compared to the other types.

Production of the B-17, which totaled 12,731 of all types, was eclipsed by that of the B-24 Liberator, a later aircraft hurriedly designed with the single intention of getting as many bombs on target as possible, with little regard to aesthetics or handling characteristics. In fact, over 6,000 more Liberators were built than B-17s, a numerical advantage of 50%. To this day, however, the Flying Fortress continues to outshine the Liberator as the flagship of the United States Army Air Forces and a symbol of victory and American ingenuity and know-how. It was that kind of airplane.

## Wings of Power B-17G Certified Specifications:

- Top Speed @ SL: 220 mph TAS (45,000 lbs)
- Top Speed @ Alt: 287 mph TAS @ 25,000 feet (45,000 lbs)
- Cruise @ 5,000 ft: 150 mph IAS/ mph TAS @ 29" Hg/1650 rpm (60,000 lbs.)
- Cruise @ 25,000 ft: 140 mph IAS/207 mph TAS @ 29" Hg/1750 rpm (60,000 lbs.)
- Climb: 38 minutes to 20,000 ft (62,000 lbs.)
- Climb: 62 minutes to 30,000 ft (62,000 lbs.)
- Fuel to climb (25,000 feet): 232 gallons
- Distance to climb (25,000 feet): 140 miles
- Takeoff distance to clear 50 feet: 4,190 feet (62,000 lbs.)
- 1 g stall speed, clean: 102 mph IAS (50,000 lbs.)
- 1 g stall speed, landing: 90 mph IAS (50,000 lbs.)
- Slow flight: stable with good rudder control up to the point of stall.
- Stall: Very mild wing drop. Recovery is routine.
- Empty weight: 36,135 lbs.
- Ramp Weight (fully equipped with oil and crew): 38,849 lbs.
- Maximum takeoff wt: 64,500 pounds
- Vmax: 270 mph IAS
- To Gear Down: mild pitch down
- To Flaps Down: mild pitch up
- Engines: Four Wright R-1820-97 air-cooled 9-cyl. radials
- Takeoff power: 1200 BHP @ 46" Hg/2500 RPM
- Emergency power: 1350 BHP @ 55" Hg/2760 RPM
- Normal climb power: 850 BHP @ 38" Hg/2550 RPM
- Max cruise power: 820 BHP/35" Hg/2300 RPM (Auto Rich)
- Normal cruise power: 610 HP/30" Hg/2000 RPM (Auto Lean)
- Fuel capacity: 3,600 gallons with bomb bay tanks



## Liveries

B-17G-85-BO 43-38414 LN-Y "Heaven Sent", 350th BS/100th BG, 1945



Heaven Sent was built on 31st July 1944 and was assigned to the UK on 1st August the same year. It failed to return from a mission on 6th February 1945 after it crash landed in Rochseter. It was salvaged and returned to the United States after the war where it was stored at Kingman, Arizona prior to being scrapped.



B-17G-25-BO, Serial 42-31684 - “JOKER” of the 774th BS 463rd BG, Celone, Italy, May 1944.



Joker flew with the 774th Bomber Squadron based in Italy from 9th March 1944 until it was shot down during a mission over Blechhammer on 7th July 1944.

B-17G-10-BO, Serial 42-31225, "Scheherazade"



Built by Boeing at the Seattle plant and delivered to the Army Air Force on 4 October 1943, and assigned to the 709th Bomb Squadron, then at Harvard AAB. She was flown to England as part of the original assignment of the 447th Bomb Group to Rattlesden in November 1943. Scheherazade is credited with flying 126 missions without a single mechanical abort. Scheherazade was one of only three original aircraft of the 447th to survive the war and return to the US. In July 1945, she was flown back to the US, and sold to the Reclamation Finance Corporation for scrap.

B-17G-110-VE, N3193G "Yankee Lady"

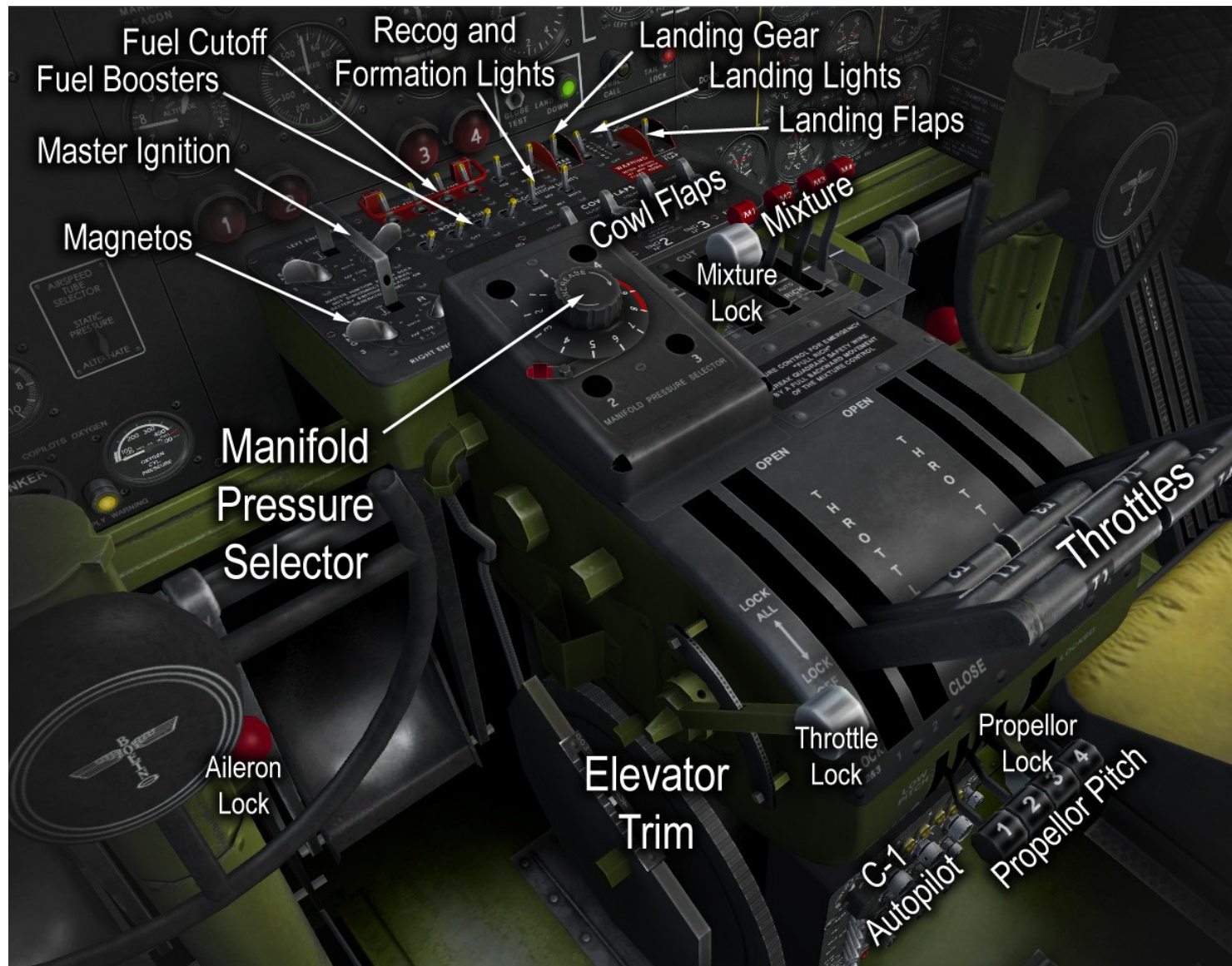


This aircraft was delivered to the U. S. Army Air Corps as 44-85829, then transferred to the U. S. Coast Guard as PB-1G, BuNo 77255 in September 1946. It served at NAS Elizabeth City, North Carolina until May 1959. Ace Smelting Incorporated of Phoenix, Arizona bought it on May 11, 1959, gave it its current registration, then sold it to Fairchild Aerial Surveys of Los Angeles, California the same month. Aero Services Corporation of Philadelphia, Pennsylvania acquired it on August 2, 1965 and sold it to Beigert Brothers of Shickley, Nebraska on October 1, 1965. Aircraft Specialties Incorporated of Mesa, Arizona bought it on March 19, 1966 and flew it as tanker c34 and later tanker #34. It was flown to Hawaii in January 1969 to appear in the movie Tora Tora Tora. Globe Air Incorporated of Mesa, Arizona acquired it along with B-17G-85-DL, N9563Z on February 18, 1981. It is now named "Yankee Lady" and flies for the Yankee Air Museum at Ypsilanti, Michigan.

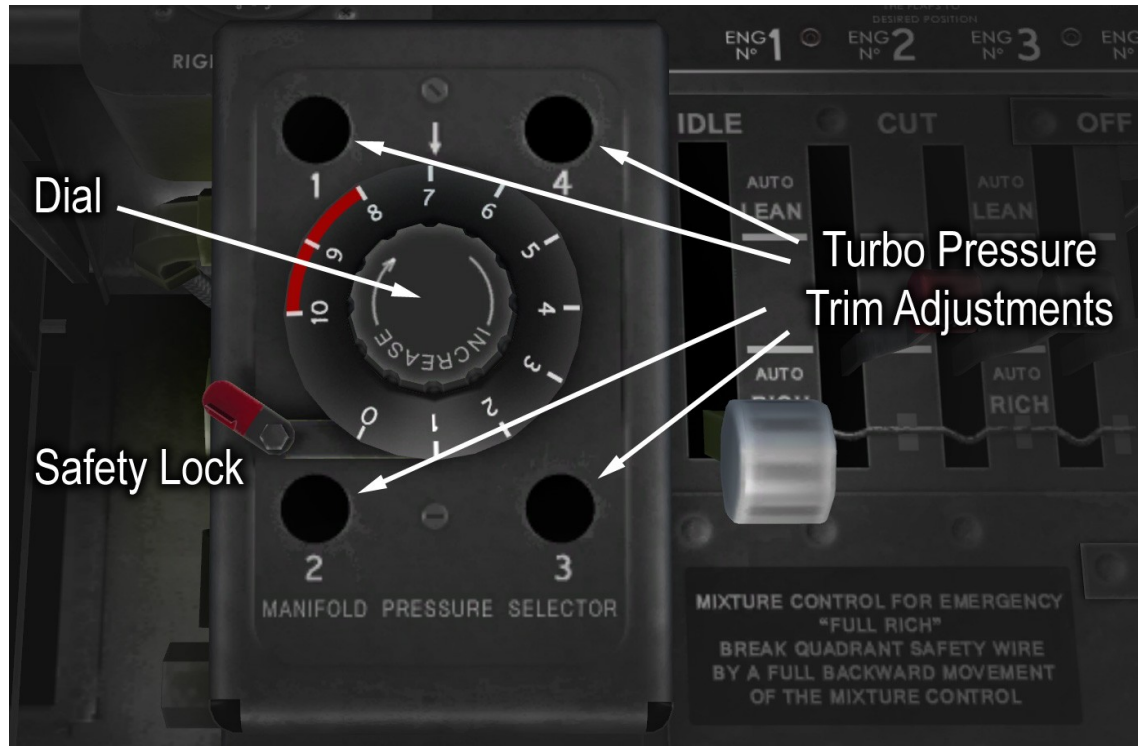


# Cockpit

## Center Console



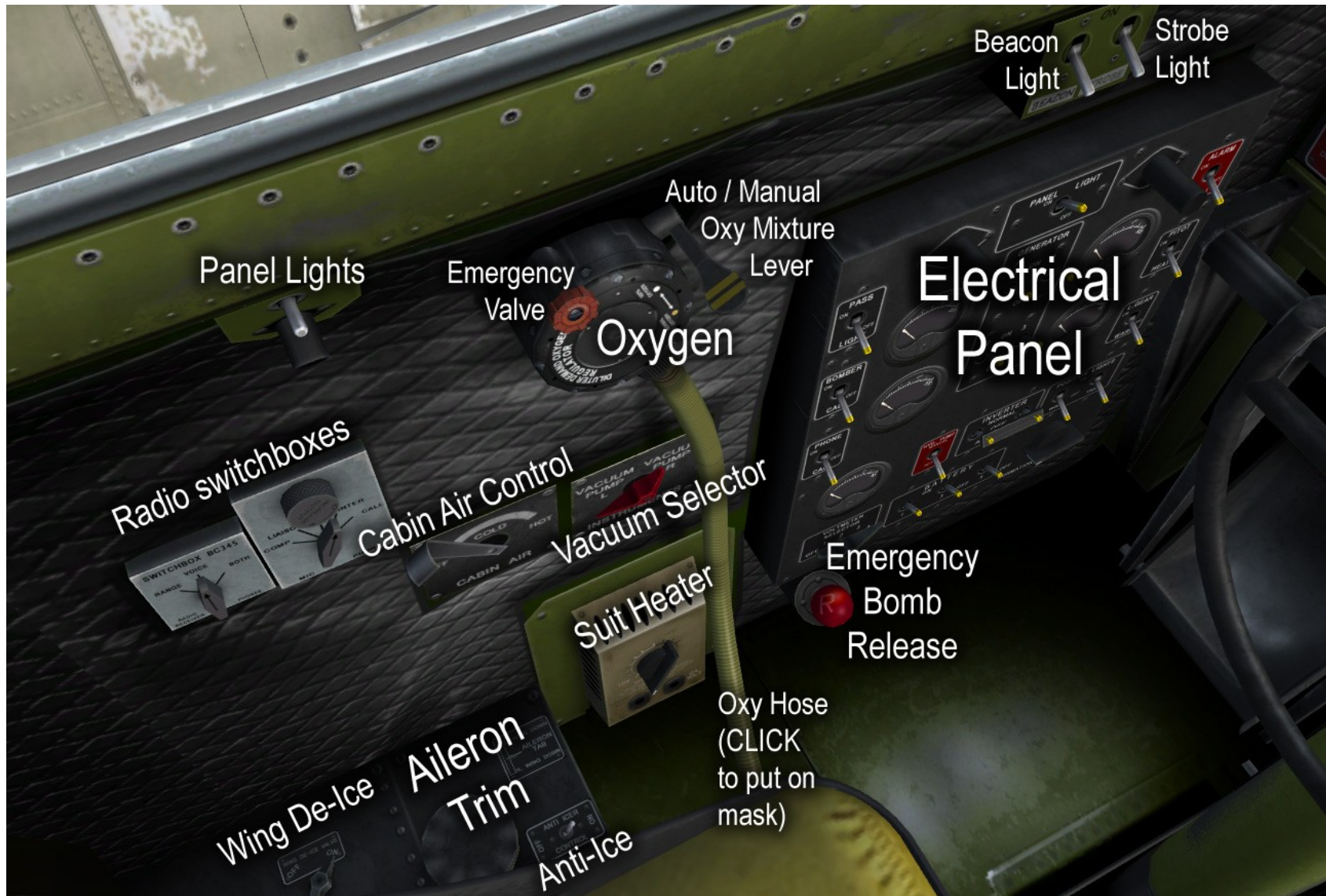
## Manifold Pressure Selector



The Manifold Pressure Selector allows for almost effortless control of all four engine turbochargers

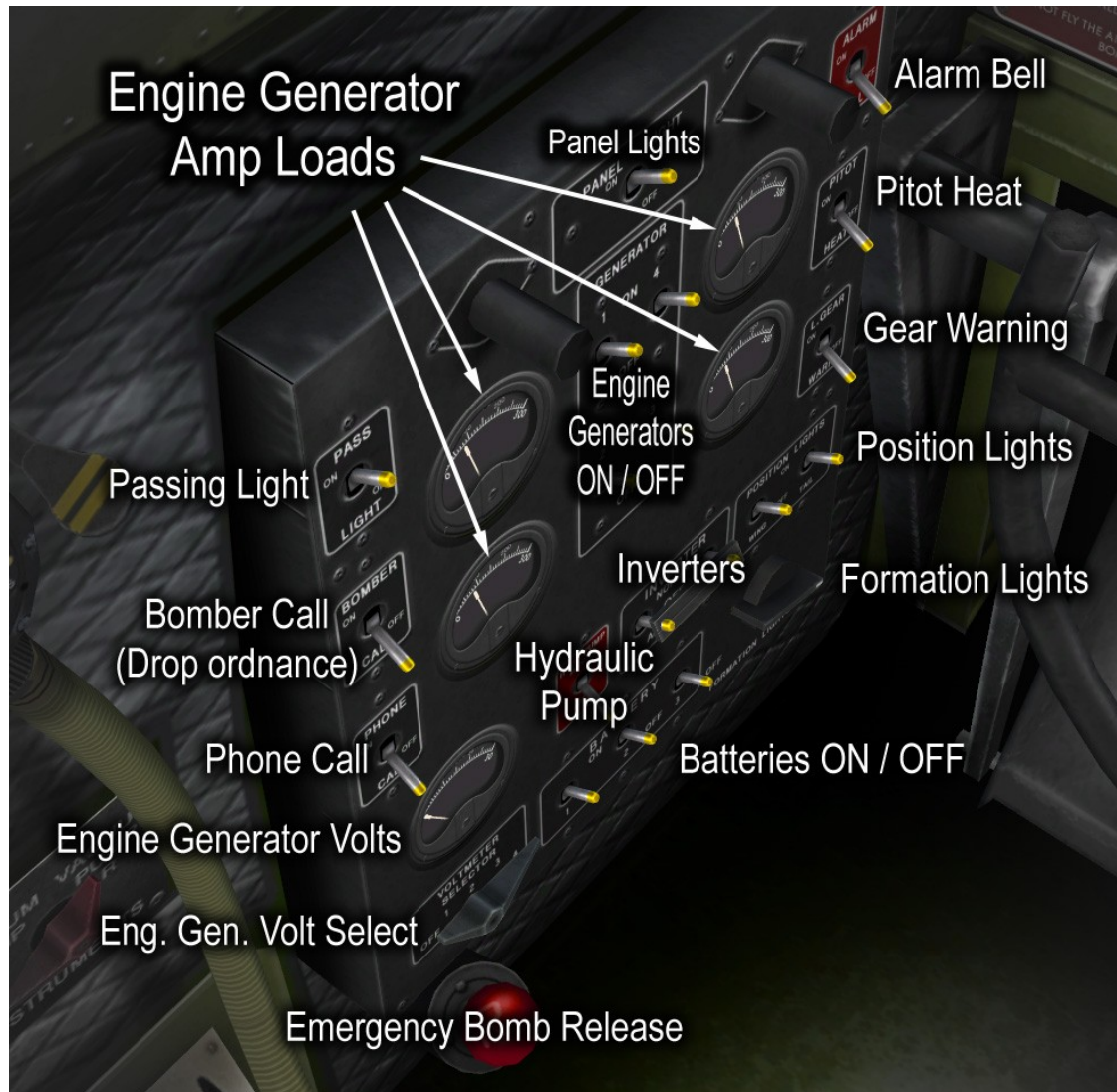


## Pilot Left



Interior lighting, Oxygen, Cabin Air Control, and the Electrical Panel can be accessed here.

## Electrical Panel



You can monitor the amp load on each of your engine generators on this panel. The more demand that is placed on the generator, the higher the indicated amp load.

**Inverters** supply electricity to the bomb bay warning lights, flaps indicator, and most critically, the turbo control motors.

**Batteries** can be checked on the ground by turning each on one and listening to the 'whine' of the inverters, placed under your seats.

The **hydraulic pump** auto mode can be bypassed and set to manual in the event hydraulic pressure has fallen below the 200psi critical level. The switch is spring loaded and needs to be held in the manual position.

The **bomber call switch** will order your bombardier to drop whatever is in the bomb bay. You can also pull the emergency release handle (bomb-bay doors must be opened).



## Pilot Front



Primary instruments like compasses, PDI, hydraulic pressure, suction, and warning lamps are quickly accessed here for the pilot in command.

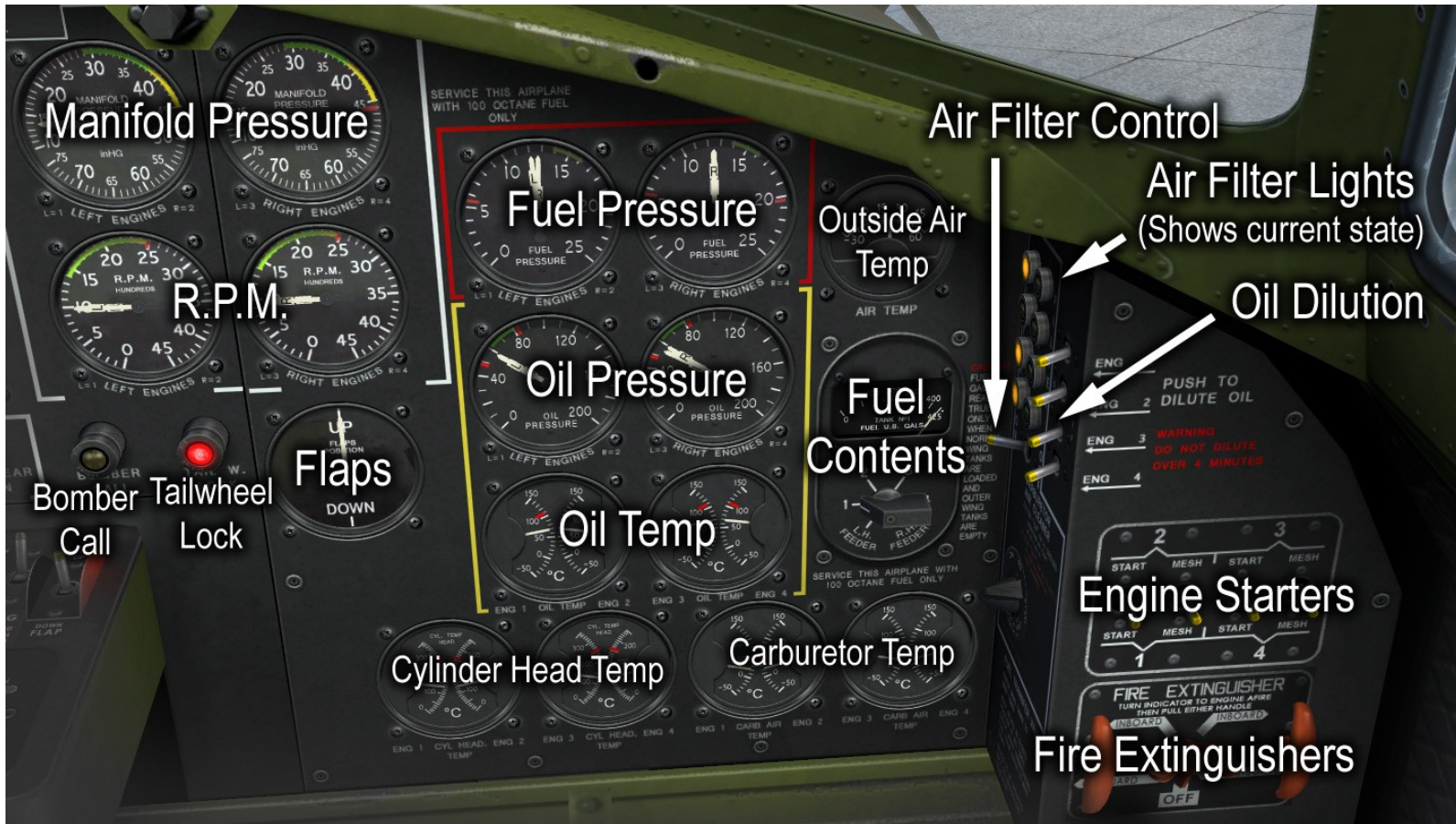
## Center Front



Shared instruments between the pilot and co-pilot can be accessed here including altitude, airspeed, I.L.S., heading, turn & slip, artificial horizon, climb, manifold pressure, engine R.P.M., flaps, and prop feathering.



## Co-Pilot Front



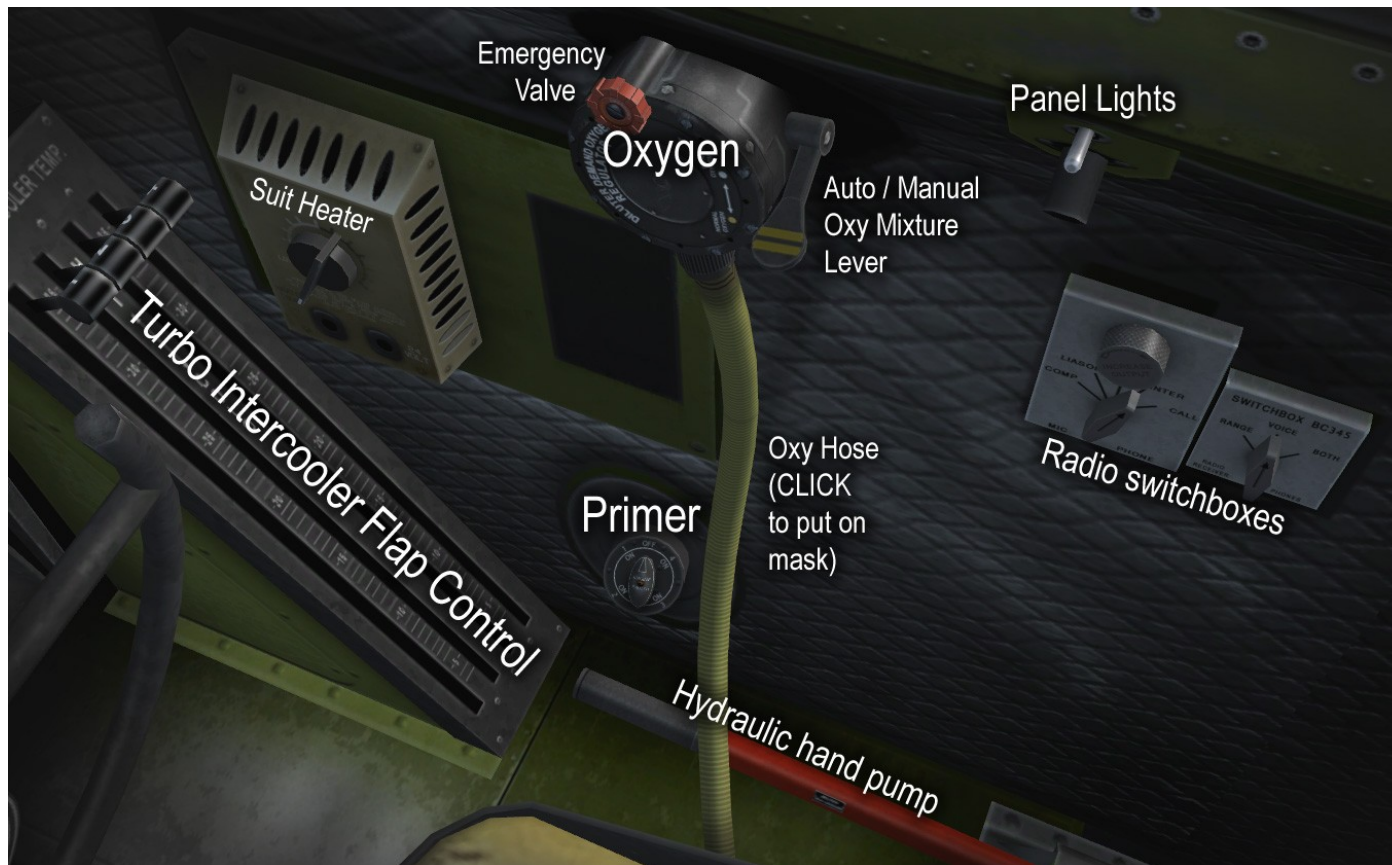
The co-pilot typically starts and manages the engines, so critical engine instruments like fuel pressure, oil pressure, oil temp, cylinder head temp, air filter control, oil dilution, available fuel, engine starters, and engine fire extinguishers are all here.

## Co-Pilot Front Corner



This is a closer look at the cockpit section in the front corner where the co-pilot sits.

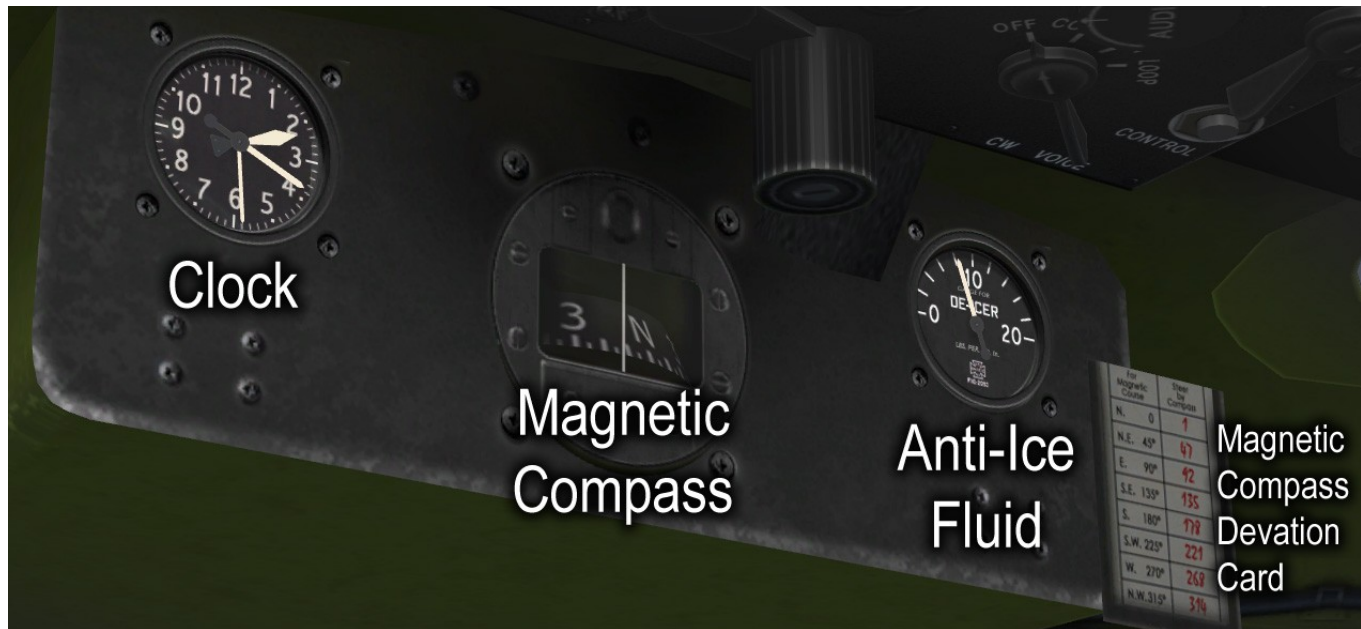
## Co-Pilot Right



The co-pilot also manages the turbo intercooler flaps to manage carburetor temperatures, his oxygen equipment, engine primer for starting, radio, hydraulic hand pump, and panel lights.



## Upper Panel



Both the pilot and co-pilot have clear access to the clock, magnetic compass, and anti-ice fluid in this upper panel.

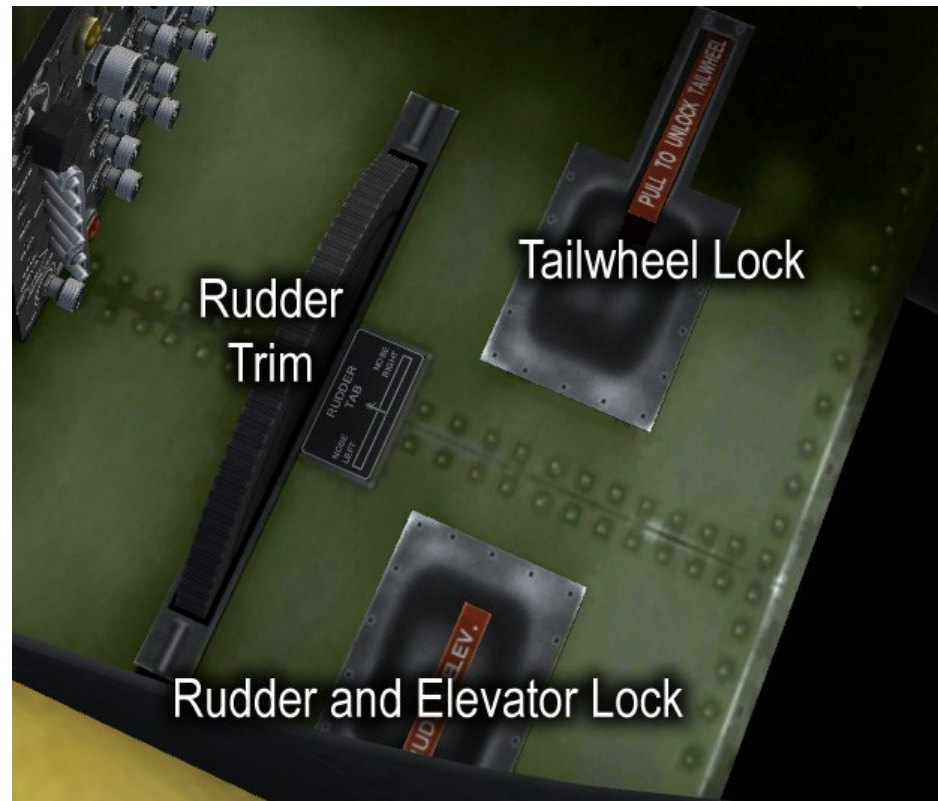


## Radios

These are older radios and much of their functionality is no longer supported in today's modern aviation world, but the ADF and communication channel selection can still be utilized. For radios, use the 2d pop-up panel (SHIFT-6).



## Center Floor



Both the pilot and co-pilot have access to this middle floor section between their seats. The pilot can use his right hand and the co-pilot can use his left hand to lock / unlock the rudder / elevators, lock / unlock the tail wheel, and trim the rudder.

## Induction System

### Manifold Pressure

The manifold pressure in your B-17 is your best way to judge the power your engine is producing. However, be aware that manifold pressure is simply the pressure of the air before it enters your engine and, more accurately, is an indication of “potential” power.

Assuming manifold pressure is the same, the following things can affect the actual power your engine is producing:

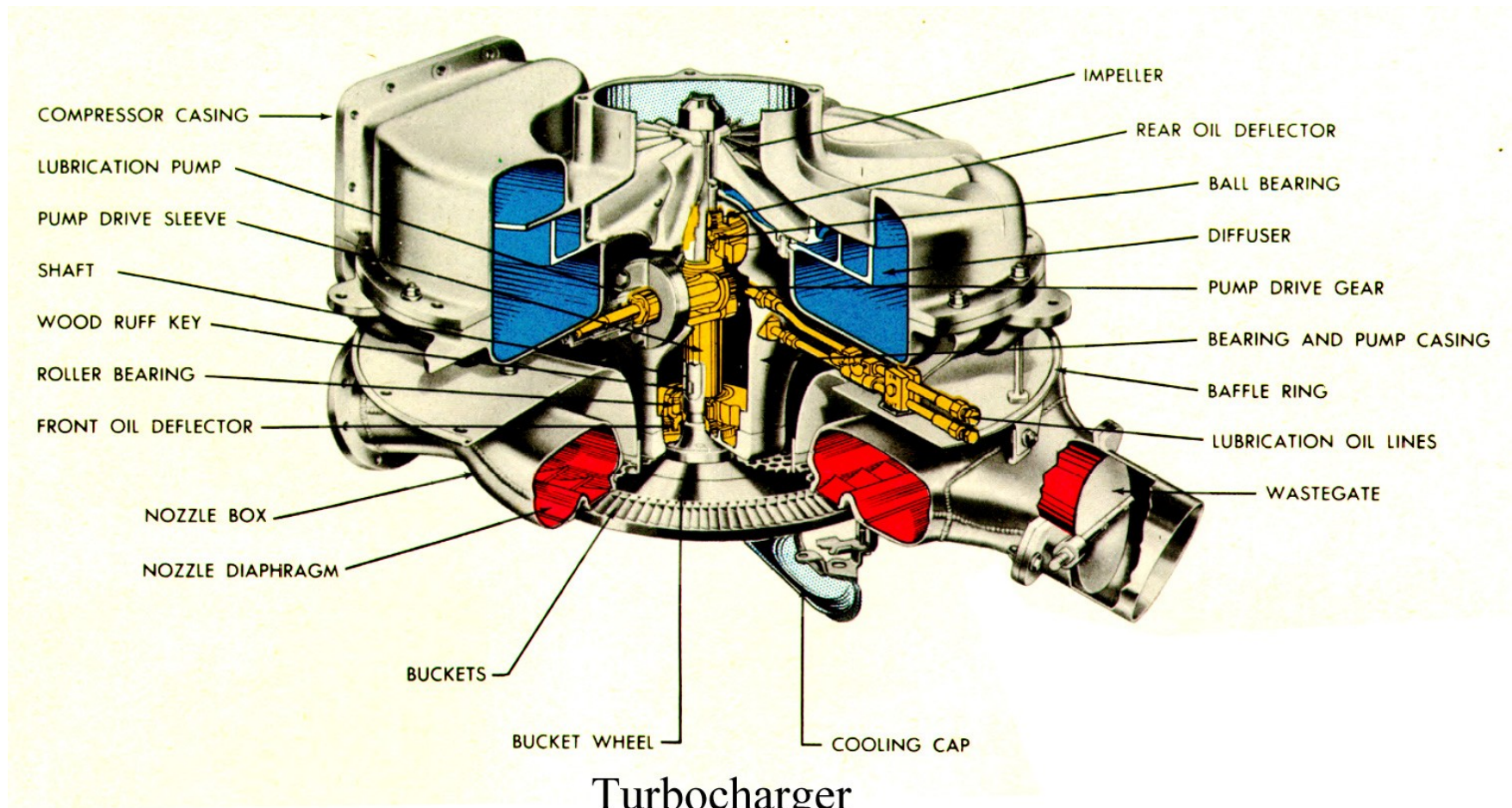
1. **Mixture.** If your mixture is too lean or too rich it will produce less power than if it is at the optimum power-rich setting. Your mixture is constantly changing based on the power your aircraft is producing. In certain circumstances, Auto Lean can produce more power than Auto Rich since at high power settings more fuel is added to keep the engine cool. If the power is high enough, Auto Lean may actually provide the best power mixture. However, you do not want to apply high power with Auto Lean, this is just something you should be aware of.
2. **Engine health.** An old worn engine will not have the tight compression a new engine will have and this older engine will produce less power than the newer one at the same manifold pressure.
3. **Carburetor Air Temperature.** For the most part, cooler air is denser and will produce higher manifold pressure, but manifold pressure and power output can be inconsistent at different carb air temps.
4. **RPM.** Higher RPM means higher power output. **Never** use low RPM and high manifold pressure. This condition can create critically high torque and stress a motor.





## Turbo-supercharger Overview

A type B-22 General Electric turbo-supercharger is provided for each engine to boost manifold pressure for takeoff and high altitude flight. Superchargers are controlled by an electric manifold pressure selector on the pilots control pedestal.



## Manifold Pressure Selector

The Manifold Pressure Selector, also known as the Turbo Boost Control is located on the pilots center aisle stand. A dial has divisions numbered from "0" to "10". The dial range from "0" to "8" is used to select the desired manifold pressure for all normal conditions. When properly calibrated a dial setting of "8" should provide a maximum takeoff power (1,200 HP at 46"). The dial range of "8" to "10" is red-lined and should be only be used for emergency military power. The dial stop prevents dial rotation beyond eight unless the dial stop release is pressed.

**IMPORTANT:** Dial settings and manifold pressures referred to are for 100 octane gasoline. Proper allowances must be made when using fuel with a lower octane rating. For example: a dial setting of "7" should be used for takeoff power with 91 octane fuel.



This little knob controls the following:

- The Manifold Pressure Selector, is the actual unit you turn. This unit allows the pilot to set the desired maximum pressure, and the unit then sends electrical signals to the turbo waste gate, holding this pressure from sea level to 30,000 feet and beyond.
- The *Pressuretrol* directly monitors the air pressure in the induction system and sends this information to the system so it can compensate for changes in altitude, holding the pressure you, the pilot, have dialed in.
- The *Turbo Governor* monitors the turbo speed, preventing it from accelerating too rapidly, and also limiting it to a top speed of 26,400 RPM.
- The *Waste Gate Motors* directly controls the position of the waste gate, ultimately increasing or decreasing the turbo power as needed.

## Ground Calibration

If the engine run up check shows all four engines to be operating normally, the control system may be calibrated. Calibration should be made with 100 octane gasoline if possible, however it is not necessary to change calibration settings when changing grades of gasoline. The system should be calibrated when any of the units have been replaced, but it should not be necessary to change the settings during regular engine run up procedures or pre-flight checks if the initial calibration has been made carefully. Therefore variations in manifold pressure will then indicate engine trouble or a malfunction of the turbo control system.

**IMPORTANT:** Do not use the calibration adjustment to compensate for engine malfunction. Use the following procedure for ground calibration:

1. Start engines and go through usual low power engine run up a check. Check to see that inverters are on.
2. Set propellers to maximum.
3. Set **MANIFOLD PRESSURE SELECTOR** to "8" (100 octane fuel)
4. Advance throttles to full open position
5. With throttles full open and take off RPM, calibrate each engine individually by turning the calibrations screw clockwise to increase manifold pressure and counterclockwise to decrease manifold pressure. Calibrate each engine to within 1 inch of takeoff manifold pressure (45 inches). In actual takeoff, ram air may temporarily increase manifold pressure by 1", but will eventually be compensated by the automatic turbo manifold pressure system.

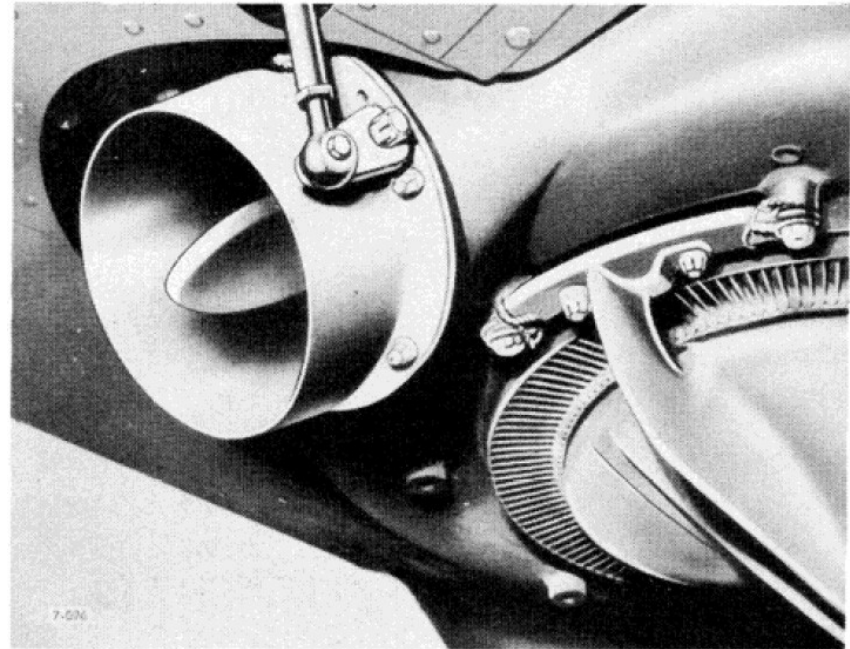
**NOTE:** It is not recommended that calibration settings be changed in flight unless absolutely necessary.

## High Power Climbing to High Altitudes

The inboard engines have lower critical altitudes than the outboards by approximately 2000 to 3000 feet and furthermore, the #2 engine has an additional 1500-foot lower critical altitude (See explanation below) than the #3 engine due to the glycol heaters in the exhaust stack. What this means is if you are climbing at max climb, your #2 engine manifold pressure will start to drop first, then #3, then finally your #1 and #4 engines will drop. This is due to your turbocharger RPM limiters preventing your turbos from exceeding their maximum RPM.

### Critical Altitude

As your aircraft climbs into higher, thinner air, the turbocharger fans must run faster to compensate for the continual loss of pressure. Like any mechanical system, the turbo fan has a maximum speed at which it can run. The altitude at which this maximum speed is reached, is the engine's "critical altitude." Your B-17 has a turbo RPM limiter that will prevent the turbo fan from running at too high a speed. Assuming you leave your Manifold Pressure Selector dial alone, as you climb to your critical altitude, the manifold pressures seen in the cockpit should remain fairly consistent due to your turbocharger fan increasing speed to compensate. Once you pass through this critical altitude, you will notice manifold pressure starts to drop off. This is because the turbo has flat-lined at it's maximum output, and continuing to climb into thinner air then has a direct impact on the manifold pressures seen in the cockpit.



Turbo Wastegate (opened)



### Carburetor Air Temperature (CAT)

This is the temperature of the air before it enters your engine. As you climb, the turbochargers squeeze the air more, resulting in hotter air temperatures. These temperatures can be read on the co-pilot's side of the cockpit, on the Carb Air Temp gauges. To cool the air, move the intercooler levers down towards **COLD**. This causes more outside air to pass through the intercoolers, to cool the air before it enters the carburetor. If the carb air is too cold, move the intercooler levers up towards **HOT**.

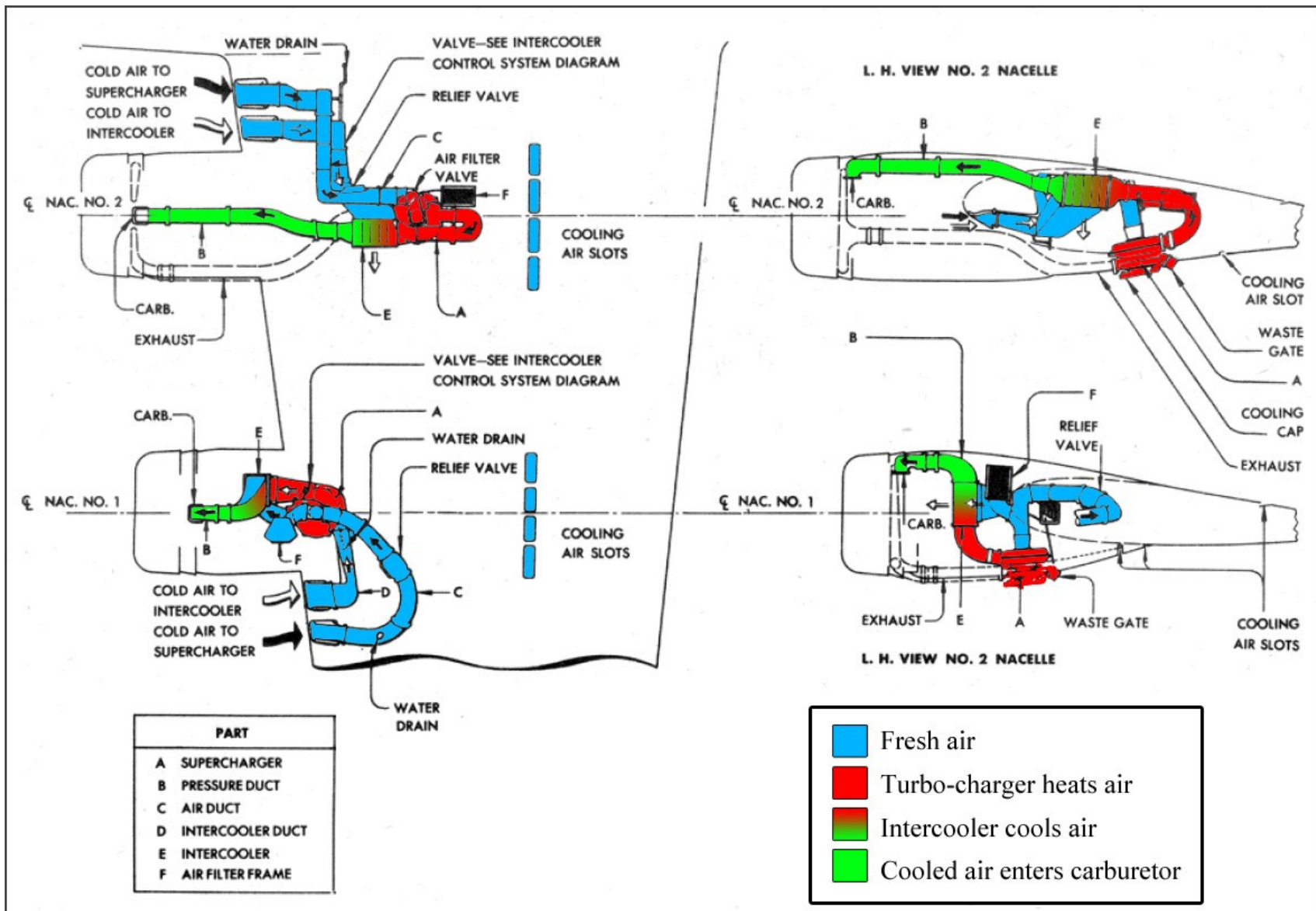
The intercooler control levers are located on the right side of the cockpit. Also be aware that when your air filters are on, warmer air is being drawn from the inside of the wing. At some point during your climb to high altitudes (8,000-15,000ft), you will turn your air filters off which will then pull direct, ram air from the leading edge of the wing. Your carb air temps will be a little less and your turbochargers won't have to work so hard with the increased air supply and air pressure from the ram air effect.



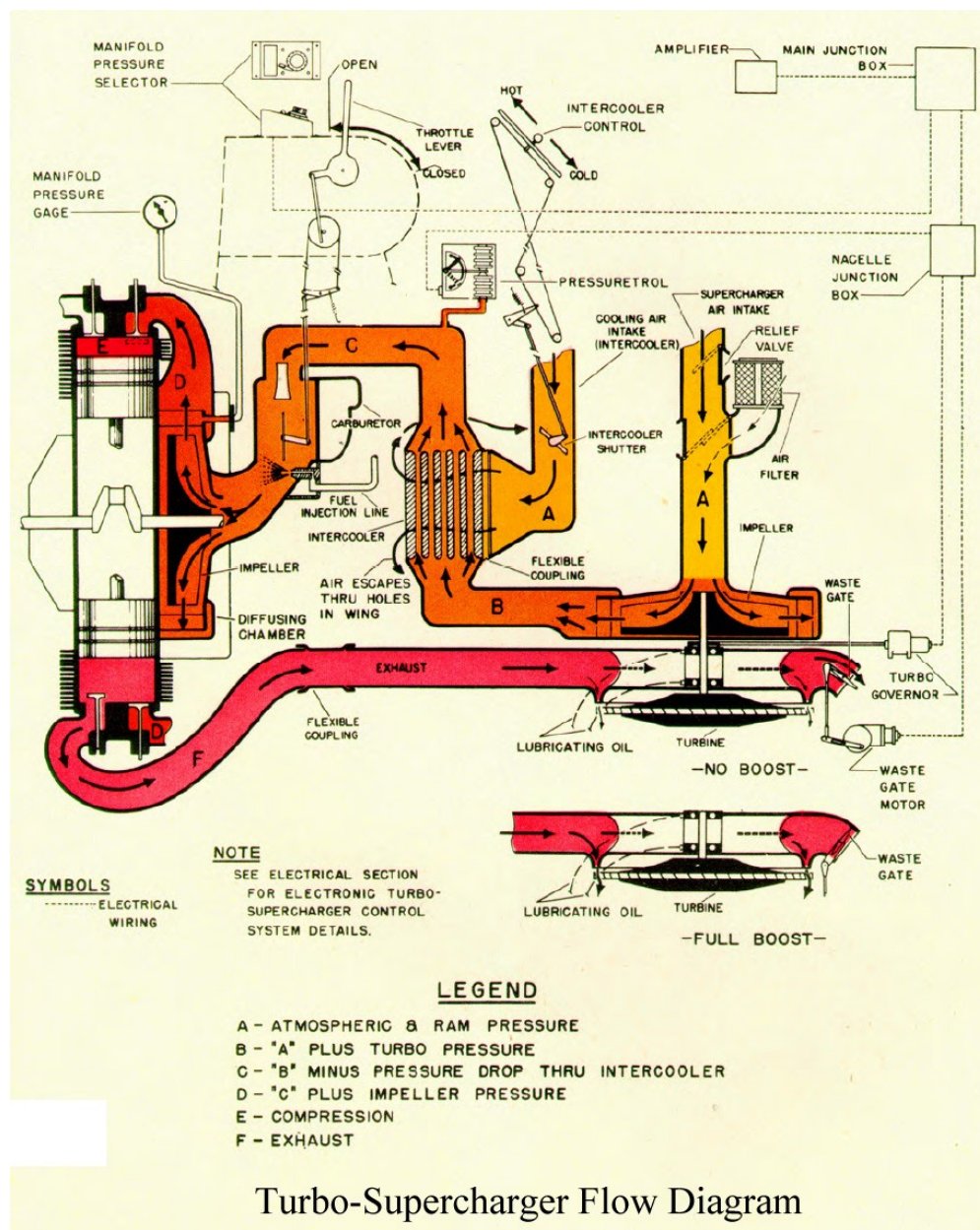


## Air Flow Diagrams

Below is a diagram showing the air as it enters the engine, it is heated by the turbochargers, then cooled by the intercoolers (you control the cooling power with the intercooler levers in the cockpit), then enters the engine at the desired temperature.



Here is a more detailed diagram showing the flow of air as it enters the ducts, is compressed by the turbocharger, cooled by the intercoolers, then sent into the carburetor.



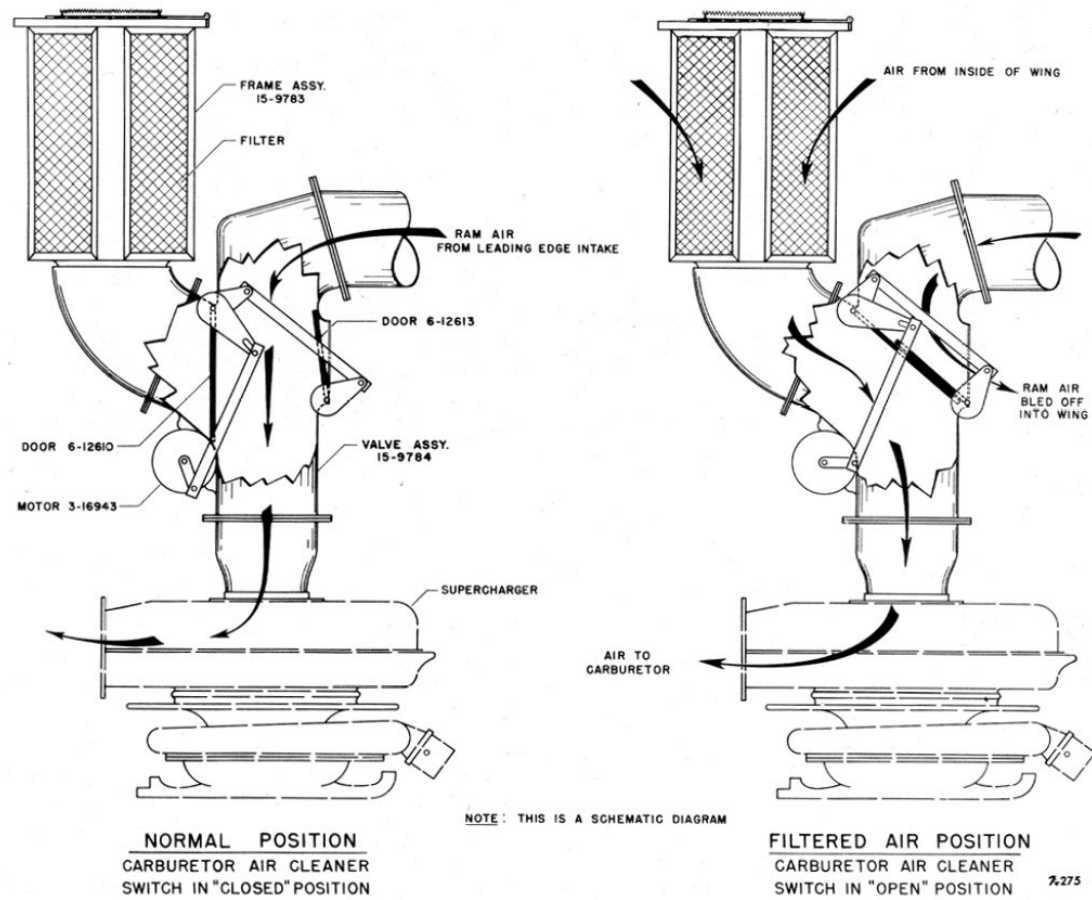
Notice that once the air enters the carburetor, it is then combined with fuel to create the air/fuel mixture. That air fuel mixture then enters the supercharger (hence, the turbo-supercharged system). Air is again heated but not to the extreme levels of the turbocharger.

The supercharger on the Wright 1820 engines fitted into your B-17 are mild superchargers, designed for a modest boost increase of roughly 20-30%. The turbochargers do most of the 'heavy lifting' in terms of getting the very thin air at high altitudes to acceptable pressures to produce adequate horsepower.

Note the flow of exhaust gas and how it pushes the lower turbine, producing the power.

## Carburetor Air Filters

Operator air filter valve motors are controlled by one double-throw toggle switch located on the side of the panel forward of the copilot. When all the valves are "ON" permitting only warmer, filtered air (from inside the wing) to enter the supercharger intakes, four amber lamps are lit. Four green lamps are lit when the control valves are "OFF" permitting only ram air (from the ports on the leading edge of the wing) to the supercharger intakes. Air filters should be "ON" for all ground operations and for altitudes up to 8,000 feet. Use of the filters above 15,000 feet should be avoided since the operation above that altitude is accompanied by a rise in carburetor inlet air temperature, increasing the possibility of detonation. This condition is aggravated by abnormally high outside air temperatures. **In all cases the filters must be closed above 15,000 feet!** Failure to observe this precaution may cause detonation and the needless overworking of the turbochargers.



Carburetor Air Filter Control



## Ram Air

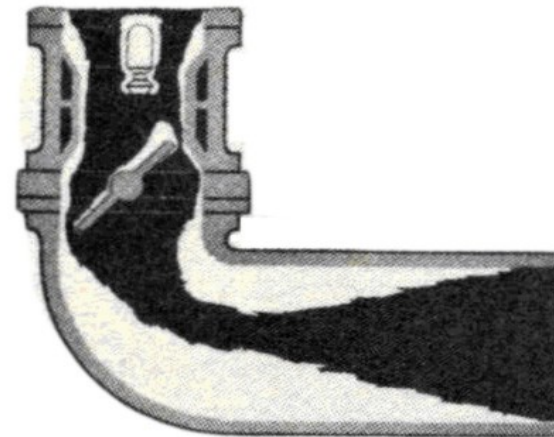
When you turn your air filters off, then the air coming into the intakes at the leading edge of the wing takes a more direct route to the carburetor. This essentially means the pressures in the intake system increase with speed, as the air is being more compressed with more speed. For example, if you dial in “8” on your Manifold Pressure Selector on takeoff, you will see roughly 45” of pressure when you begin your takeoff run. By the time you reach the end of the runway, in excess of 100mph, your manifold pressure may increase about 1” as the turbochargers compensate for the additional ram air pressure. Once in the air, at 150-200mph, pressures should settle back to 45”

When you turn your air filters on, then air is re-directed through an air filter mesh. Not only is this ram air effect negated, but as that filter becomes dirtier, your engine will have to pull harder for the same amount of air, thus creating more of a vacuum in the induction system. This means running with a dirty air filter can result in lower manifold pressures when not using the turbo, or overworking your turbochargers when in use.

## Carburetor Icing

If the temperature is 'right' and there is moisture in the air, you can experience carburetor icing. Carb icing is dangerous as it can cause your engine to quit in flight if you do not recognize the symptoms and respond accordingly. The B-17 does not have CARB HEAT like many other aircraft since a heater is not needed to eliminate icing.

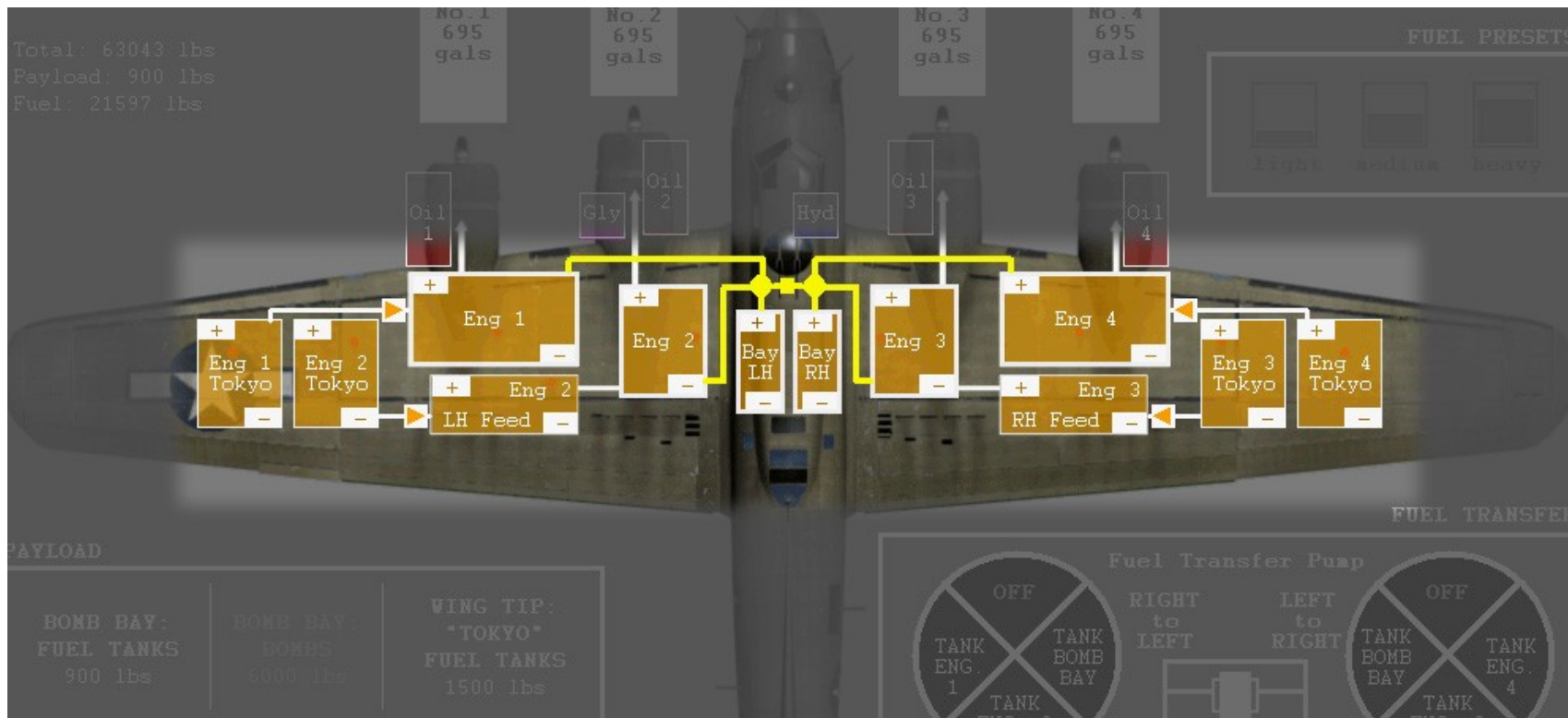
Carburetor icing may occur in outside air temperatures up to 50° in high humidity. Ice formation in the carburetor or at the fuel nozzle is indicated by a drop in manifold pressure and possibly some engine roughness. Ice may be eliminated by moving the intercooler shutters to “HOT”. If this does not work, set the turbo Manifold Pressure Selector to 8 and adjusting manifold pressure with the throttles. This makes your turbo fan run faster, compressing the air more and therefore heating it up (essentially, your turbo is your carb heater). Below 15,000 feet the air filters may be used to provide drier warmer air from inside the wings.



If the supercharger is not effective in eliminating carburetor icing with reduced power settings, keep up your power and reduce speed by lowering the landing gear and using partial flaps.

## Fuel System

### Fuel tanks



Each engine draws fuel directly from its own tank. The outer engines (1 and 4) each have a single large 425 gallon tank, while the inner engines (2 and 3) have smaller 213 gallon tanks. Due to their smaller sizes, the inner engines also have a supplementary 212 gallon feeder tank, which brings each inner engine to the same 425 gallons. You can also install long range Tokyo tanks that add an additional 270 gallons to each engine. The Tokyo tanks and the feeder tanks are all gravity fed, so you, the pilot, do not need to make any changes in flight as these tanks will all drain into the main tanks until they are empty.

Lastly, you can install auxiliary 410 gallon fuel tanks in the bomb bay. For these tanks however, you need to use the fuel transfer pumps to move fuel in or out of these tanks into any of the four engine tanks.

In total, the B17 can carry 1/3 of it's weight in fuel for a total of 3,600 gallons of fuel, weighing 21,600 pounds.

## Fuel Indicator

A liquidometer indicator, on the extreme right side of the instrument panel, shows the available fuel supply in anyone of the six main fuel tanks. A six-position switch directly below the indicating dial selects the tank to be checked.

## Fuel Shutoff Valves

An electronically operated fuel shutoff valve (model Electromatic No. 2660) is installed in the line between the fuel booster pump and the fuel filter. The shutoff valves are to be used in emergencies such as an engine fire. The valves are spring loaded and are normally opened. They are closed from the pilots center console fuel shut off switches as long as electric current is on.

## Fuel Booster Pumps

Electrically driven fuel boost pumps (model Thompson TFD 12,000), controlled by toggle switches on the central control panel, supply pressure required for engine starting and supplement the engine driven fuel pumps for takeoff and for high altitude flight. The booster pumps are normally turned off after a takeoff is well underway and started again at 15,000-18,000 feet to prevent vaporization in the fuel lines to the engine driven pumps. Booster pump pressure at the number three engine is used to supply the fuel priming system.

## Fuel Filters

A fuel filter (also referred to as a fuel strainer) is mounted on the forward side of each firewall.

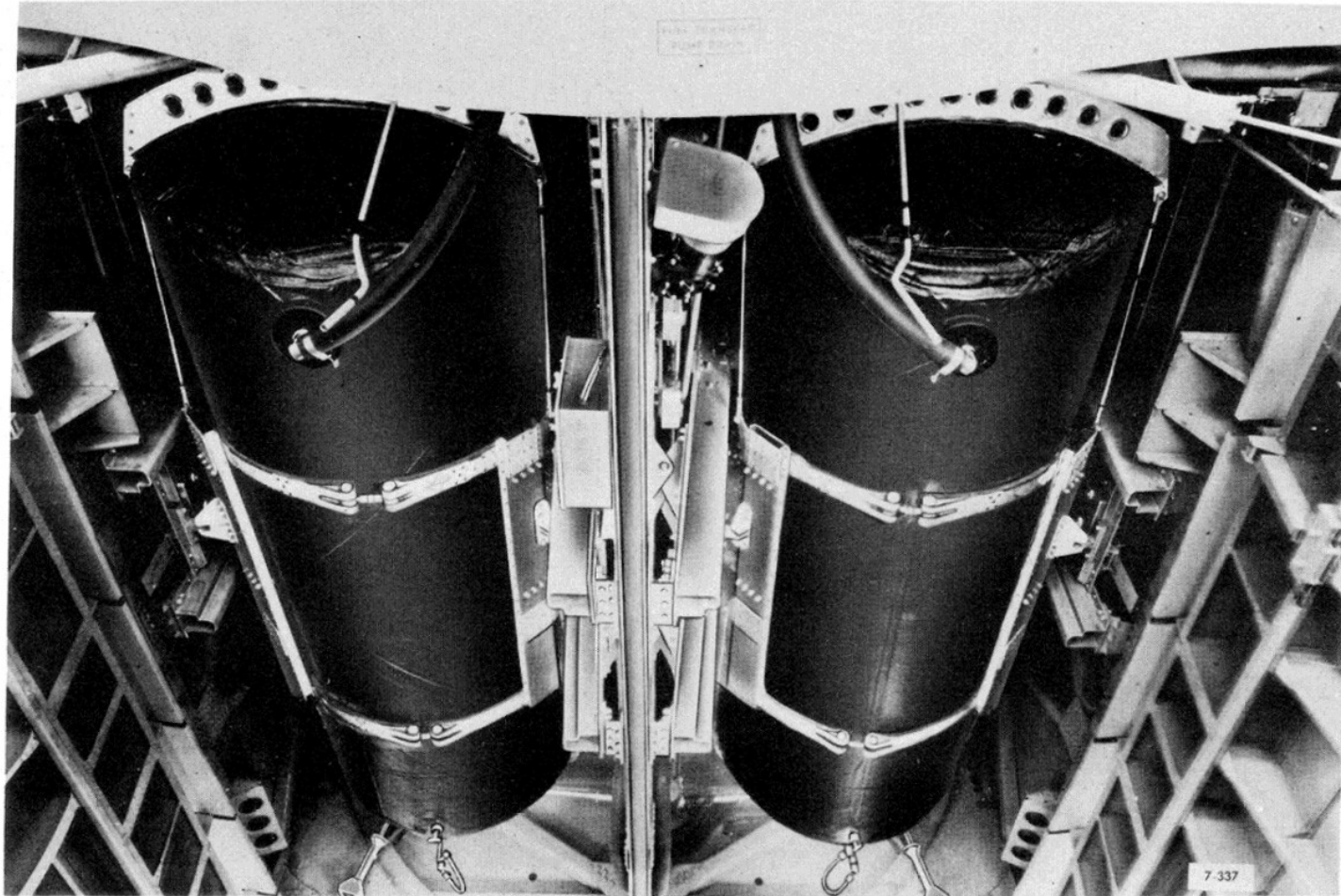
## Engine Driven Fuel Pump

Fuel is directed to a type G-9 sliding vane fuel pump located on the right side of each engine accessory housing. Fuel pressure should be regulated between 12 and 16 pounds per square inch.



### Bomb Bay Fuel Tank Installation

Take a look at this actual photograph of bomb bay tanks installed into the bomb bay. These tanks are almost as tall as the B-17 itself, and add a considerable amount of extra fuel to this aircraft.



Bomb Bay Fuel Tank Installation

## Hand Primer

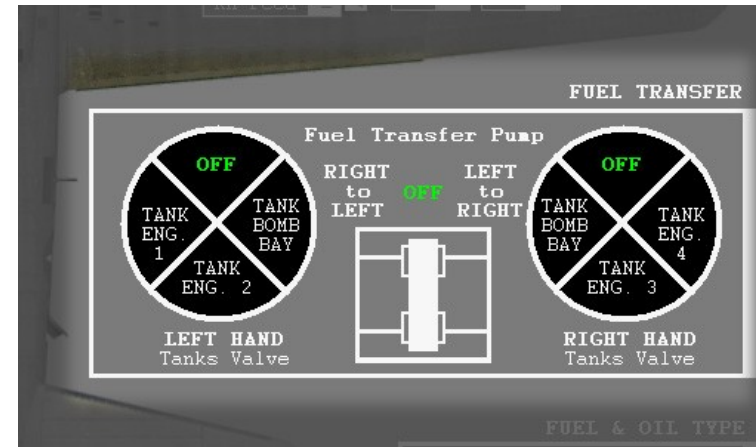
The primer system is fed from the inboard side of engine number three. A hand priming lever is mounted on the floor near the right side wall beside the copilot. A selector valve is incorporated in the unit which directs priming fuel drawn from engine number three to any desired engine. It is therefore necessary to turn on the number three fuel booster pump for priming to work.



## Fuel Transfer Pump

An electronically driven vane type fuel transfer pump (Model Romec RG 4420) is mounted in the bomb bay. The pump has a capacity of approximately 900 gallons per hour.

The fuel transfer pump is managed by two transfer valves and a switch. It is quite intuitive to use. You simply select the tank from which you wish to draw fuel, then the one you wish to pump fuel to, and move the switch in the direction you wish fuel to flow. In the real B17, you would put your hand on the pump to feel if it is working. In the simulation, you can actually hear the fuel transfer pump moving fuel. It is important that you do not run the pump dry, as the fuel acts as a cooling agent. Running the pump dry can cause it to overheat and burn out. If this happens, you will hear the unloading of fuel if the pump is running dry.



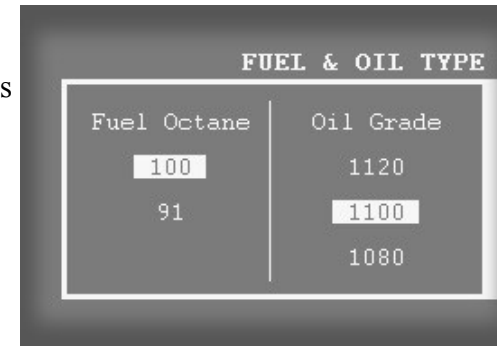
### **CAUTION:**

Fuel lubricates the pump therefore the pump should not be left running after the tank upon which it has been drawing is emptied.



### Using Different Types of Fuel

You can load your aircraft with either 100 or 91 octane av-gas. Just like an automobile, if an engine is designed to run on a specific octane of fuel, running it on a lower octane means the engine will likely not produce the same power. In the case of the B-17's engines, they were designed to run on 100 octane fuel, however in the real world, sometimes only 91 octane was available. If you have to run your aircraft on 91 octane fuel, you need to use slightly lower manifold pressure settings otherwise you risk detonating and damaging your engines. Fortunately, with the B-17, this is all managed for you with the manifold pressure selector dial located in the cockpit.



## Oil System

### Overview

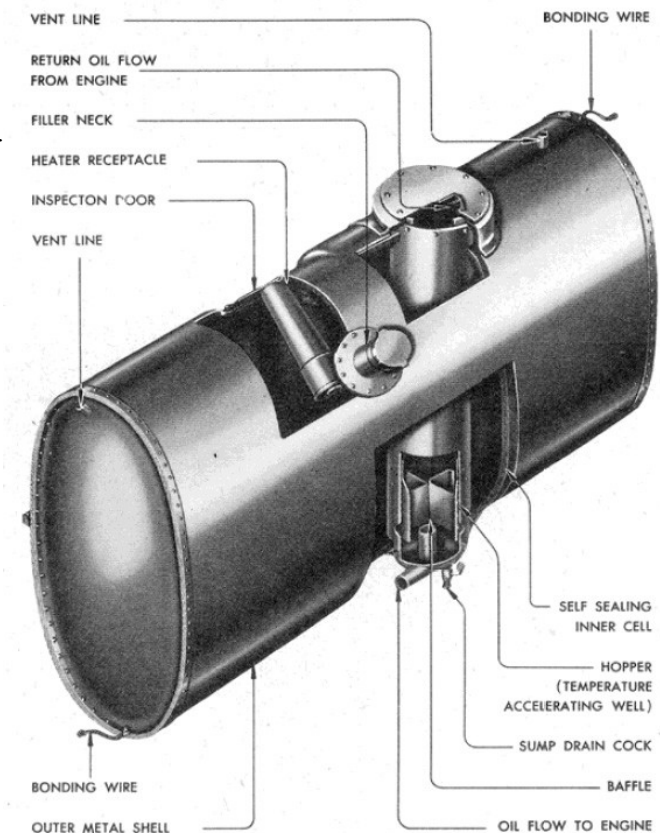
Lubricating oil is supplied to each engine individually from a self sealing tank installed between the firewall and the front bar. Each of the four tanks has a capacity of 36.9 U.S. Gallons. A self turning filter is integral with the engine and oil temperature regulator. Servicing the oil filters would help to ensure clean oil is circulating throughout the engine. Running an engine with an old oil filter will result in more abrasive particles and debris to make contact with the internal engine parts and therefore shorten the engine lifespan and any oil dependent accessories.

### Oil Pressure

Accu-Sim models oil thickness (viscosity). The colder the oil temp, the thicker it is, and the more oil pressure there is in the engine. If you start your engine on a cold morning, you may see oil pressures as high as 150 psi. This is far above the limit and it is critical that you do not push the engine with cold, thick oil. Pushing an engine with thick, cold oil can weaken or even burst oil lines and oil fittings. Let the engine warm up without pushing the oil pressure into the red.

You have two options if you have just started a very cold engine:

1. Idle below 1,200 RPM and wait until the oil temperature warms and pressure drops.
2. Turn oil dilution on.



Engine Oil Tank

## Oil Dilution

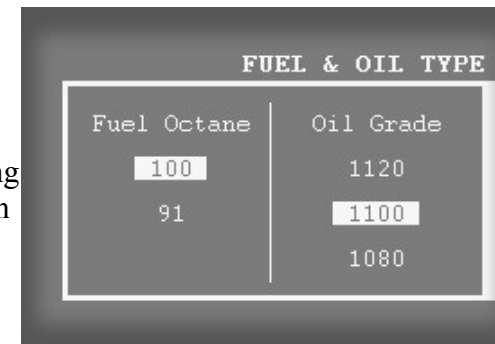
An oil dilution system is provided for diluting the oil with gasoline at the end of an engine run to provide easier starting in cold weather. Oil dilution is performed after an engine run and immediately prior to shutting off. When you turn oil dilution on, you are injecting fuel into the oil which breaks the oil down and thins it out. To dilute your oil, make sure the engine is idling and turn oil dilution **ON** for 2-4 minutes, or until oil pressure is at the desired level. Once the oil pressure is within the safe range and you take off, the oil will heat up and burn off the fuel, returning it to it's normal condition.

Also, if you are about to stop your motor and anticipate the engine will be cold (around freezing or below), you should idle the engine, turn on oil dilution for 4 minutes, then stop the engine. If the oil temp is over 70 degrees, oil dilution is not effective as the fuel burns off too fast. In this case, wait until the oil temp gets between 40-60 degrees, then dilute. If you cannot get your oil temp that low, stop the engine, wait until the oil cools, start it back up, dilute the oil, then shut it down. Save your flight. The next time you start, your oil will be diluted, which means easier starting and less risk of damage.



## Using Different Types of Oil

You can load three different types of oil grades, 1120, 1100, and 1080. The hotter the oil, the thinner it becomes, and the less effective it is as a lubricant. Thinner oil also means lower oil pressures and therefore engine parts are more likely to make contact which increases wear / shortens their lifetime. Conversely, the colder the oil, the thicker it becomes and thick oil puts a strain on the entire oil system resulting in your oil pump having to work harder to pump the oil. These high pressures increase the likelihood of leaks, blown lines, etc. So in very cold weather, a thinner oil (1080 grade) is recommended for safer starts, and in hot weather a thicker oil (1120 grade) is recommended due to higher oil running temperatures. In most climates, that are neither extremely cold or extremely hot, 1100 grade oil is adequate.



### Oil Consumption

Each engine will consume oil in a similar manner in which it consumes fuel. The harder you push an engine, the more oil passes through the piston rings and out via the combustion chamber. The older and more worn the engine becomes over time, the more likely it will burn more oil. Oil can also leak out via worn seals and oil lines. Each engine has a 36.9 gallon oil tank which should be enough for even the longest journey provided nothing is seriously wrong with the engine or it's oil system.

# Hydraulic System

## Overview

The hydraulic system consists of an electric hydraulic pump that maintains between 600-800 psi (pounds per square inch) of pressure throughout a network of hydraulic lines, holding tanks, and valves. This system is used to power your wheel brakes and move the engine's cowl flaps.

## Hydraulic Pump

The hydraulic pump is controlled via a switch on the pilot's electrical panel, on the lower left cockpit wall. With this switch in the AUTO position, pressure is automatically regulated between 600 and 800 pounds.

**IMPORTANT:** If the hydraulic pressure falls below 200psi, AUTO mode will be disabled. In the event the aircraft has sat long enough or has been serviced, and pressure is below 200psi, you must either use the hand pump on the co-pilot's side to raise the pressure above 200psi, or hold the hydraulic switch in MANUAL until 200psi is reached, then release it back to AUTO.

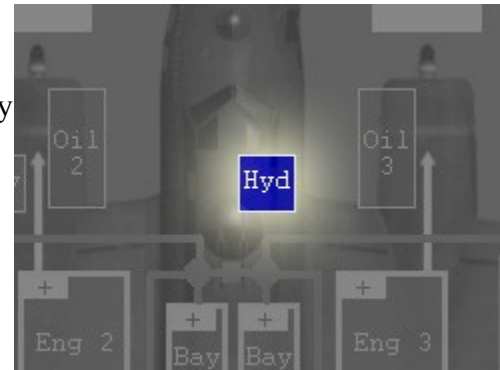


## Hand Pump

A hand pump on the side wall at the right of the copilot is used to supply pressure for ground service operations, and to recharge the accumulators if the electric pump fails. If you have ever pumped up a bicycle tire to 60-80 lbs, keep in mind that this system operates at 600-800 psi, so twenty to fifty pumps may be necessary to charge the system. Just click on the pump to pump it once. You can click on the base to make this operation easier as well.

### Hydraulic Reservoir Tank

You can check and / or fill the 4 gallon hydraulic reservoir tank which is physically located in the rear of your cockpit in the FUEL and PAYLOAD manager. As the tank is depleted, you will see the blue area lower. Click on the HYDRAULIC FLUID button in the lower left to re-fill this tank. You should check your hydraulic fluid level before every flight.



### Cowl Flap Switches

You may find it interesting that the large cowl flap switches in your cockpit center console are actually valves that re-direct hydraulic fluid to each engine's cowl flap mechanism to either open, lock, or close the cowl flaps. Hydraulic lines come into the cockpit and attach from each engine to one of these switches. This is why these are not small electrical switches, but are actually physical hydraulic valves you move. This is similar to the P-47 flap and gear levers.

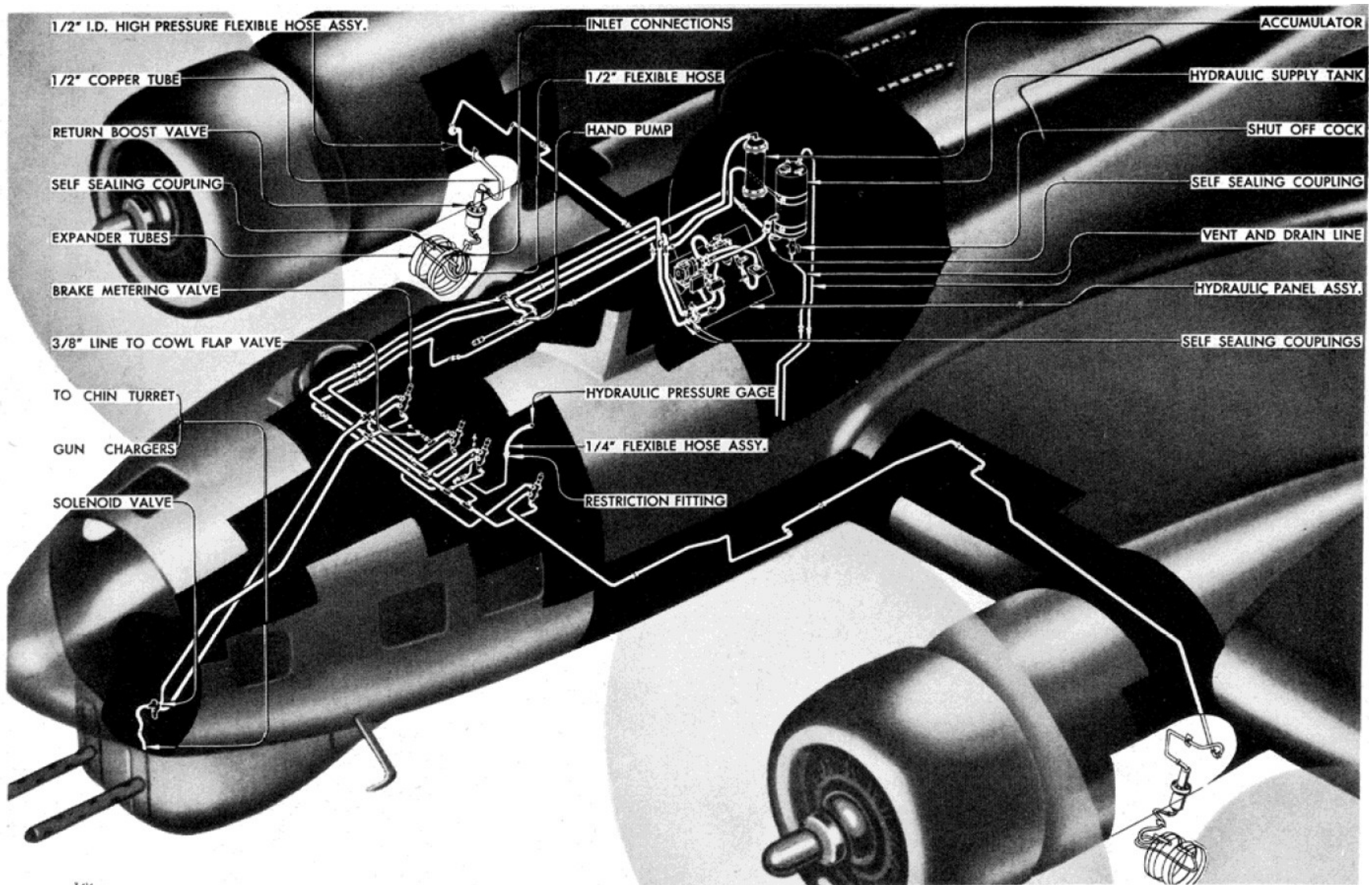


### Hydraulic Fluid Leakage

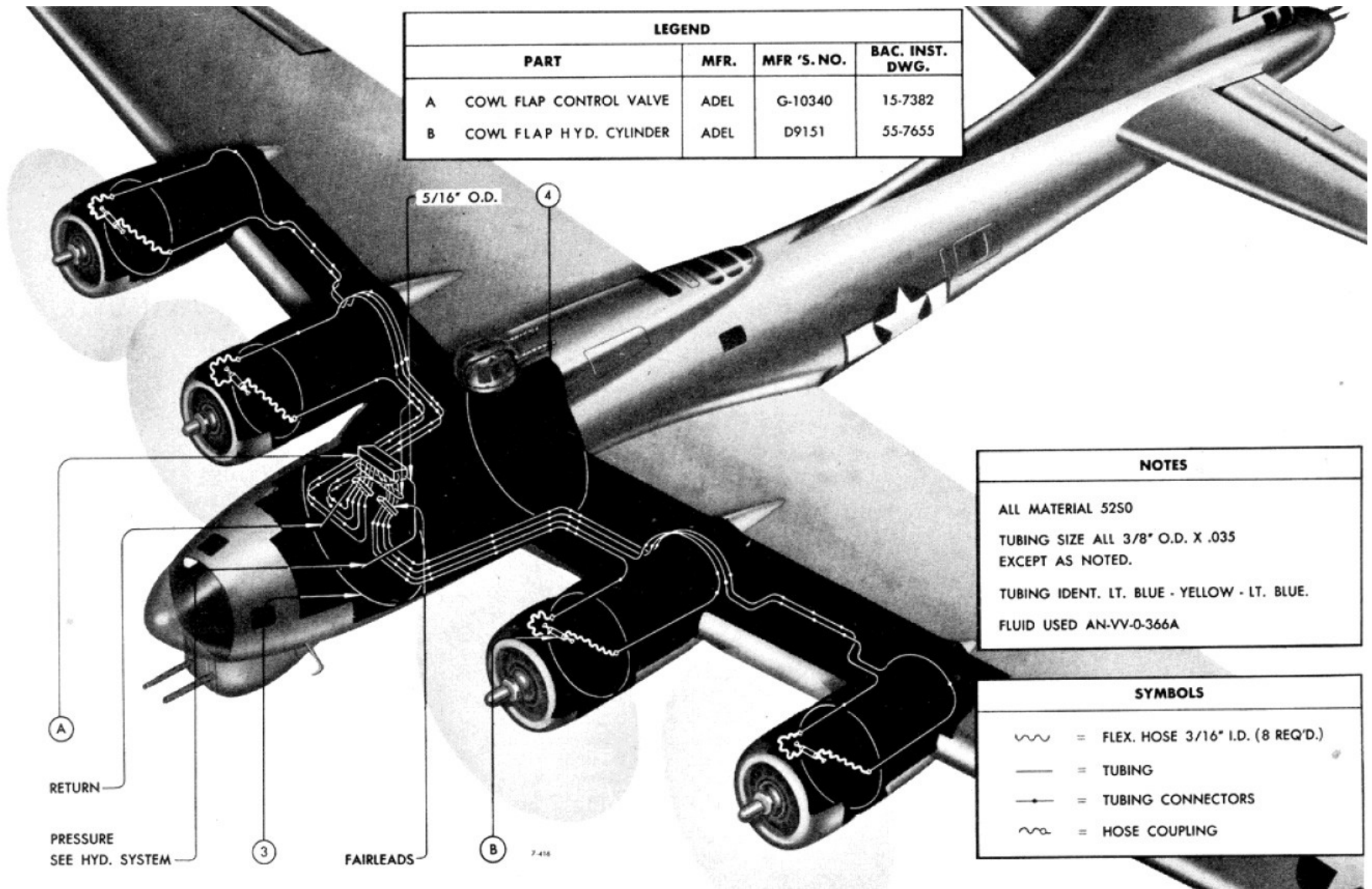
Over time, some hydraulic fluid will escape through lines and fittings. If you notice an excessive depletion of hydraulic fluid after a flight, have your mechanic check your aircraft in the maintenance hangar.



The hydraulic system diagram below shows the hydraulic tanks and piping to both the pilot and co-pilot brake pedals. The system goes out to both the left and right brake.



The diagram below shows how hydraulic lines actually enter the center cockpit panel where the hydraulically controlled cowl flap switches are located.



# Electrical System

## Overview

The model B-17G airplane is equipped with a 24-volt direct current electrical system. Electrical power is generated from four engine-driven generators and from three storage batteries in the leading edges of the wing. All four generators and three batteries are controlled by toggle switches on the pilot's control panel. A gasoline engine-driven generator unit stowed in the rear fuselage compartment may be operated on the ground to provide auxiliary electric power for recharging batteries and for limited radio operation. A double-throw switch on the pilot's control panel selects the inverter to be used: in "NORMAL" position the left inverter is on; in "ALTERNATE" position the right inverter is on.

## Generators

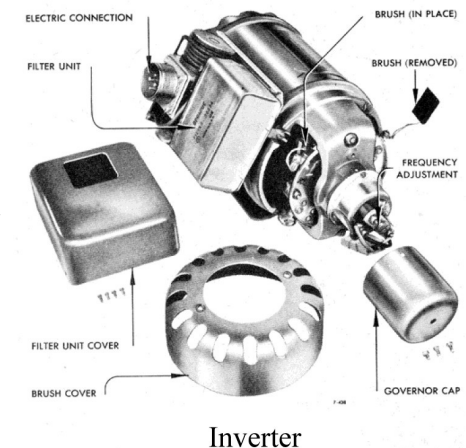
A type P-1, 24-volt, 200 amp generator is installed on each of the four engines.

## Batteries

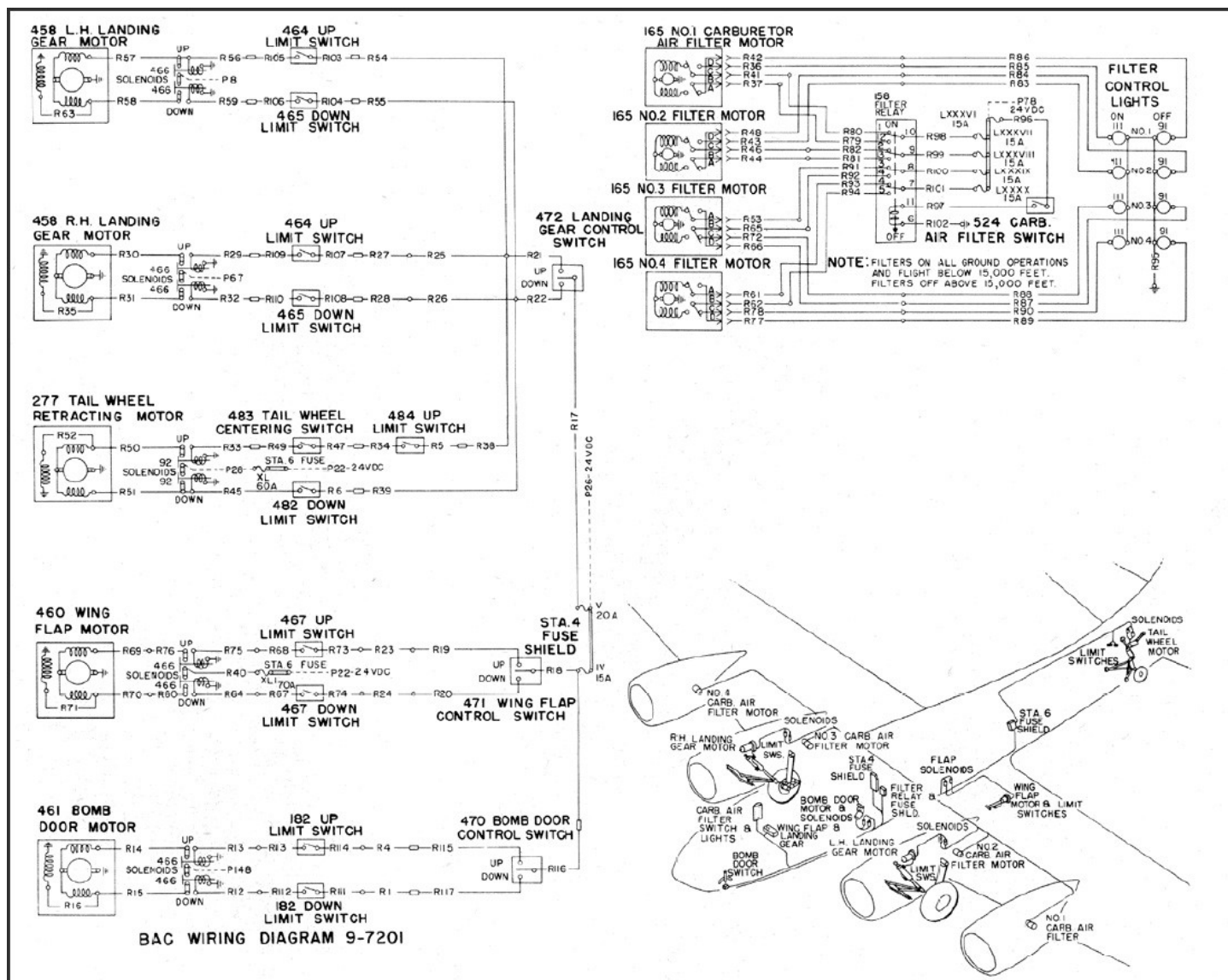
Reserve power is supplied from three type G-1, 24-volt, 34-amp hour batteries. Battery number one is installed in the left wing at the inboard end. Batteries number two and three are in the similar position in the right wing.

## Inverters

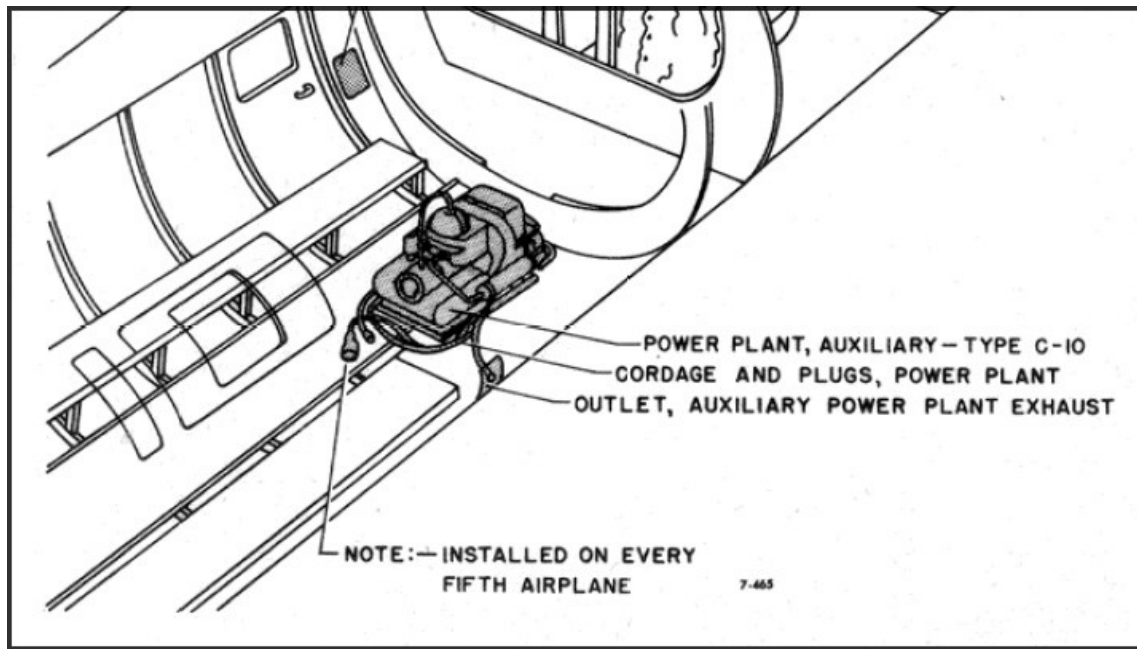
Two inverters are fitted, one under the pilot's and one under the copilot's seat. They are used to convert 24-volt direct current from the airplane's electrical system to 26-volt 400-cycle alternating current for the flap position indicator and the warning signals in the bomb bay. In addition, the inverter supply 115-volt 400-cycle alternating current for the radio compass and electronic turbo-supercharger control system. With the electronic turbo-supercharger control system installed, the inverters become one of the most vital units in the entire airplane. Should the inverters fail, control of all four superchargers is immediately lost with disastrous results. Therefore it is absolutely imperative that the alternative inverter be in good condition so that it can be depended upon in an emergency.



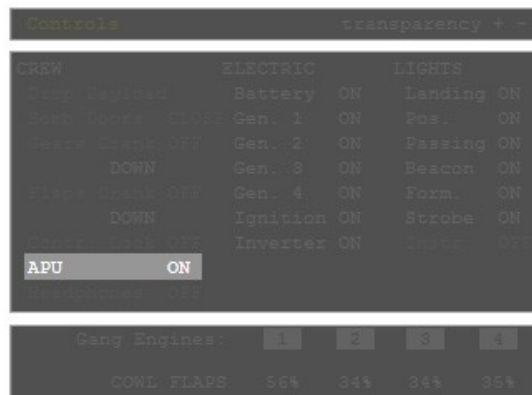
Take a look at this diagram below, showing motors for each of the main landing gear, tail wheel, flaps, bomb-bay doors, and carburetor air filters (yes, just they each have electric motors that move that flap inside each engine). For a plane built with 1930's technology, it sure was ahead of it's time with it's electrical system. Be respectful of the load all of these motors place on your generators and batteries.



## APU (Auxiliary Power Unit)



A gasoline engine-driven generator unit stowed in the rear fuselage compartment may be operated on the ground to provide auxiliary electric power for recharging batteries and for limited radio operations.



You can order one of your crewmen to turn the APU on via the CONTROLS 2D panel (SHIFT-3)

## Starters

### Combination Inertia / Direct-Drive Starters

The Wright R-1820 Cyclone is a big heavy engine, and turning it over to start requires a lot of power. A conventional starter is heavy and back in the 1940's during wartime, lowering weight was critical. The solution was an inertia starter. Basically, an inertia starter starts by spinning a wheel up to very high speeds (takes up to 10-20 sec to reach its maximum RPM), then engage that spinning wheel to the engine. If you have ever jump started a car, the inertia starter uses the same principle. When you push a car and “pop it” into gear, you are taking the stored energy (momentum) in the moving car and using that energy to turn the motor. In the case of the inertia starter, the energy is stored in the spinning wheel. When you engage this spinning wheel, the prop will lunge ahead. You may get 5 or 6 blade moves before the energy is absorbed and the engine then settles to a slower, direct drive mode.

To start, make sure the engine is properly primed and crack the throttle open. Click the starter switch for the desired engine to START to ENERGIZE. You will hear the wheel begin to spin. In about 10-20 seconds, you will notice the wheel is at it's peak speed. At this moment, move the MESH switch to MESH. The engine will kick over hard, but as the energy in the inertia wheel bleeds off, the engine will settle to a slow turn. You can add additional prime during this time if needed, but be careful not to over prime. If the engine does not start after 5 or 6 revolutions, set the START and MESH switches to neutral and start the process over. The faster the engine is cranking, warmer it is, and having proper fuel supply all contribute to the combustion process.



### Make Sure Your Engines Are Getting Fuel Before Starting

Be aware you must have your #3 electric booster pump **ON** for the primer system to work. You will hear the fuel squirt into the engine if fuel is in the #3 tank and you have fuel pressure (from the electric pump being on). You also need to have fuel pressure for the engine you are starting, so if you wish to start engine #1, for example, you will need to turn on your #3 electric fuel booster pump on for primer to work, and your #1 electric fuel booster pump on for the engine to have enough fuel pressure to start up. Some pilots use a starting sequence of 3-4-2-1, and others use a starting sequence of 1-2-3-4 (less confusing for ground crew).



## Lighting System

### Interior Lighting

Floodlighting of the instrument panel is obtained with type C-5 fluorescent lights. Clicking on the lighting switches when off will rotate them to START position, which charges the fluorescent lights. After several seconds, the switch will automatically rotate counter-clockwise to ON. Clicking on the switch again rotates the switch again counter-clockwise to ultra-violet. Ultra-violet lights eliminate window glare and reflections, since only the instrument markings and certain switches are visible.

### *Fluorescent Lights*



Above is a wide shot of the cockpit using fluorescent lighting.

Below is a closer look at the cockpit. The fluorescent lights are carefully placed to provide lighting exactly where it is needed.



### *Ultra Violet Lights*

Below is a wide shot of the cockpit using ultra-violet lighting. This form of lighting gives exceptional control over lighting, providing the ultimate night-time external visibility. Notice the single red light illuminated. This happens to be the tail-lock in the OFF position. This is typical of the excellent design of this Boeing cockpit.

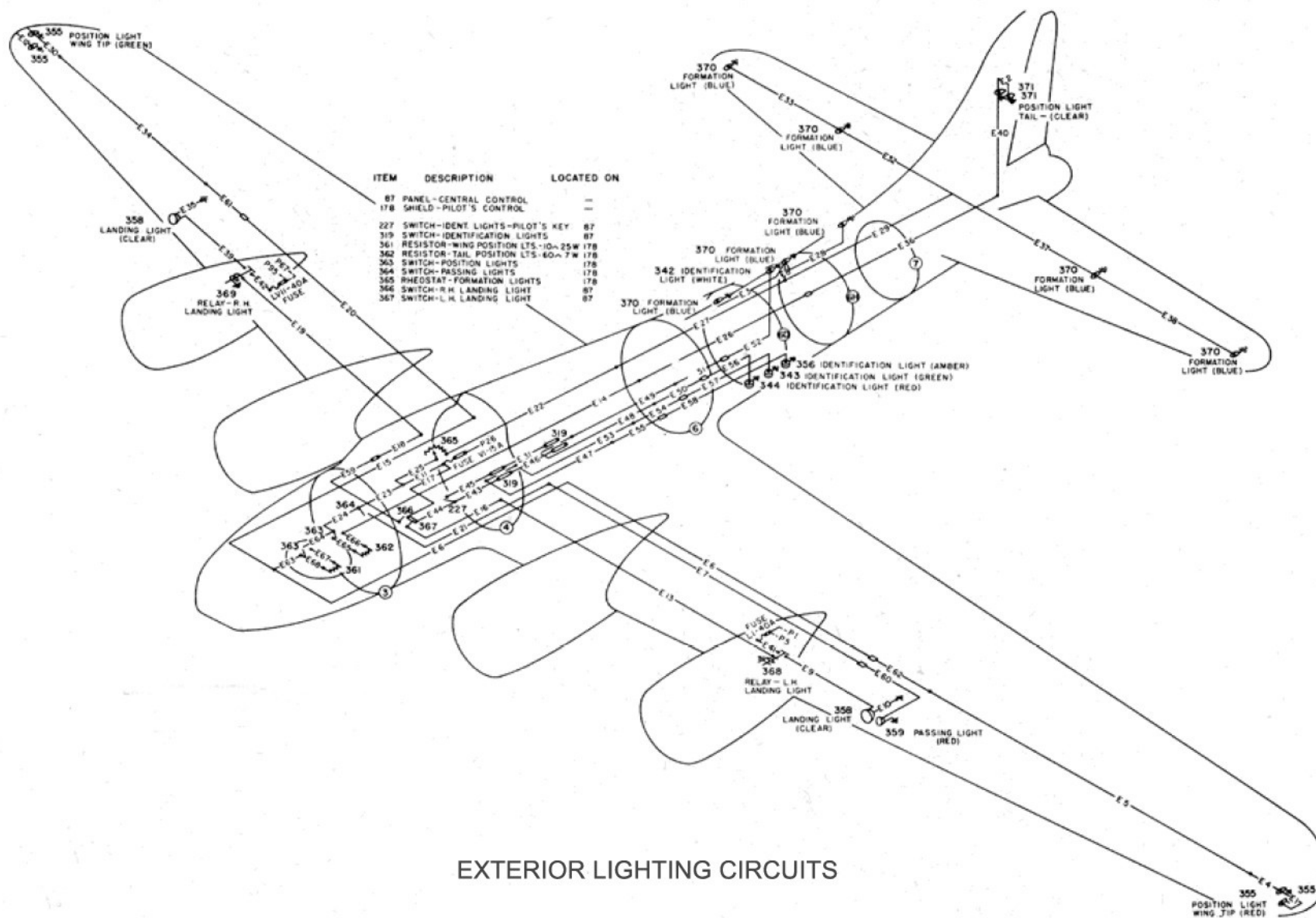


Below is a closer shot of the gauges using the ultra-violet lights. Gauge clarity is crisp.





## Exterior Lighting



EXTERIOR LIGHTING CIRCUITS

### ***Landing Lights***

Two landing lights are installed in the leading edge of each wing. Avoid using landing lights when engine generators are off, to avoid overheating the batteries. They are controlled by switches on the center cockpit control panel.

### ***Passing Light***

A passing light with a red lens is installed in the same aperture with the left landing light. The control switch is on the pilot's electrical panel.

### ***Formation Lights***

Seven body formation lights are installed, three on the centerline of the top of the fuselage and two on the upper surface of each horizontal stabilizer. They are controlled by a switch on the pilot's electrical panel.

### ***Navigation Lights (also called Position Lights)***

Type A-8 position lights are installed on each wing tip and on each side of the upper section of the vertical stabilizer. Position lights on the left wing tip have red lenses, those on the right wing tip have green lenses. Tail position lights are white. Position lights are controlled by a switch on the pilot's electrical panel.

### ***Recognition Lights***

A white identification light is installed forward of the end of the dorsal fin. Three lights, red, green, and amber, approximately 15 inches apart, are installed along the bottom of the fuselage to the rear of the ball turret. They are controlled by switches on the center cockpit control panel.

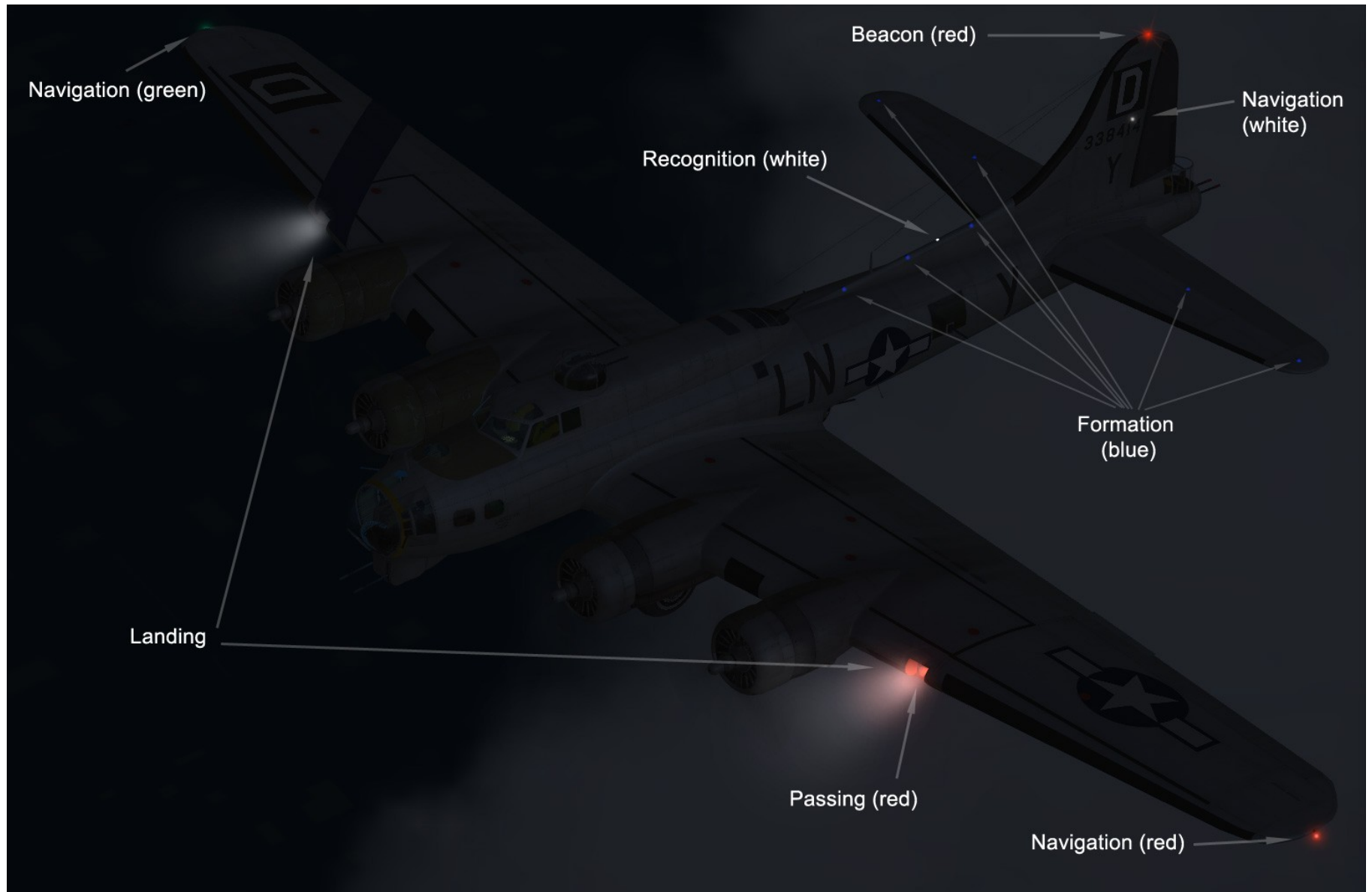


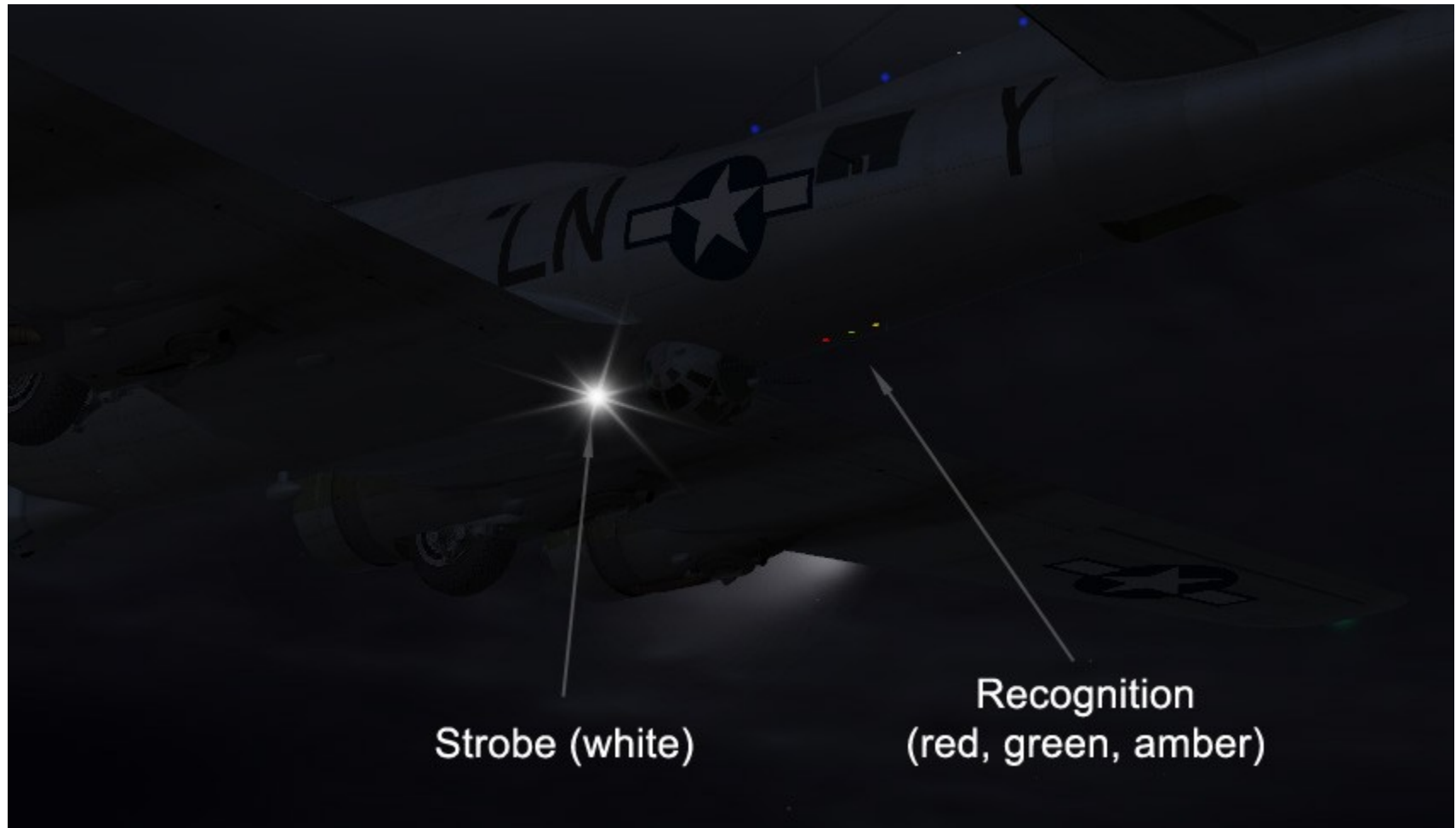
### ***Red Beacon***

Not installed by Boeing, this was added for better night time visibility for traffic above. The switch is on the pilot's electrical panel.

### ***Strobe Light***

Not installed by Boeing, this strobe light was added for better night time visibility for traffic below. The switch is on the pilot's electrical panel.





## Cabin Heating System

### Overview

This B-17 is equipped with a cabin system using a glycol fluid based system. The heating system fluid obtains its heat from the heaters mounted in the exhaust stack of the number two engine. Air is blown through a glycol heated radiator into the left side of the aircraft and baffles are set at the factory to vector air into the cockpit, nose, radio room, and waist area. The cockpit is typically the warmest and the nose and waist area are usually the coldest.

### Heater Control

The amount of heat is globally controlled by a lever on the left side of the pilot's cockpit wall. If the air is not desired for heating the cabin, moving the damper control to the "COLD" or "OFF" position will spill the heated air overboard.

**OFF:** No outside air enters the cabin (aside from open windows, doors, leaks in the cabin, etc.)

**COLD:** As you move the lever to the COLD position (12 o'clock), more fresh outside air is pumped into the cabin.

**HOT:** As you move the lever past the COLD position towards the HOT position, more air is circulated through the hot glycol radiators. The more you move the lever towards the HOT position, the hotter the air becomes.



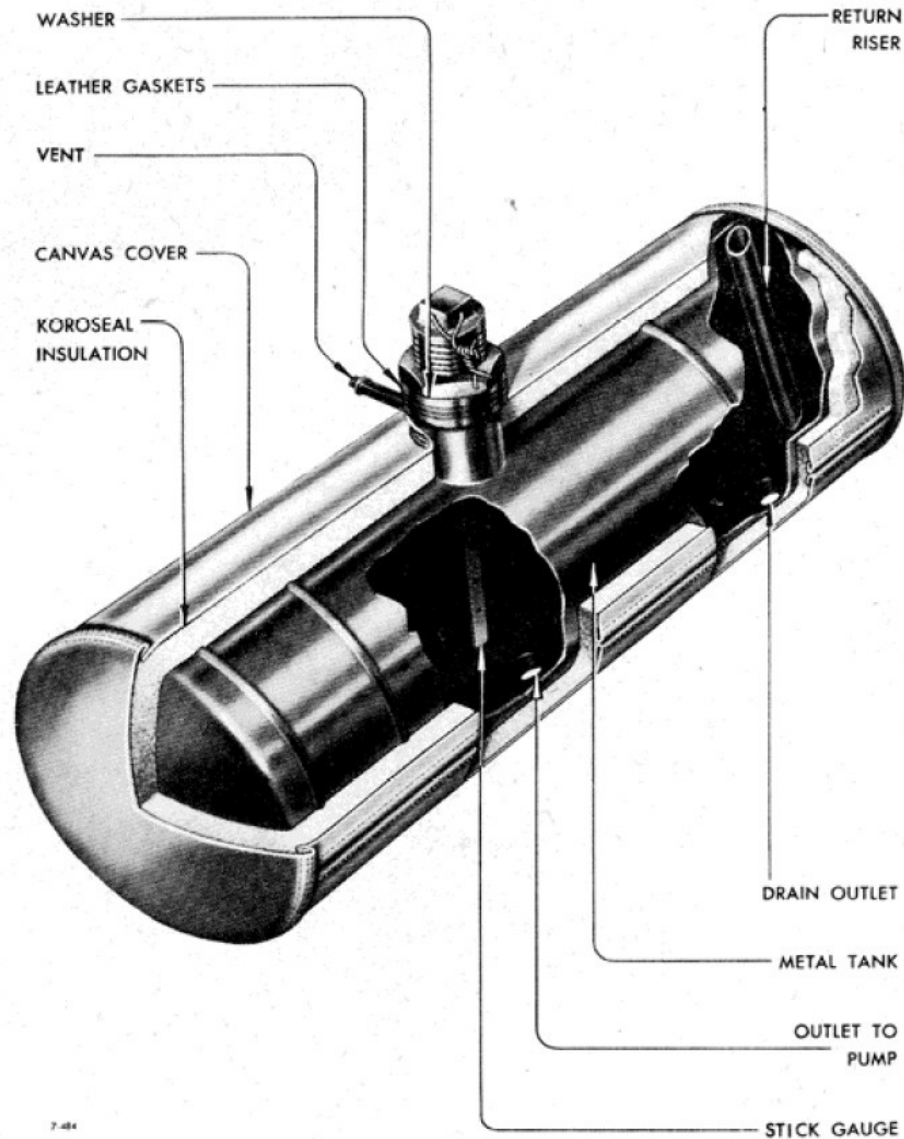
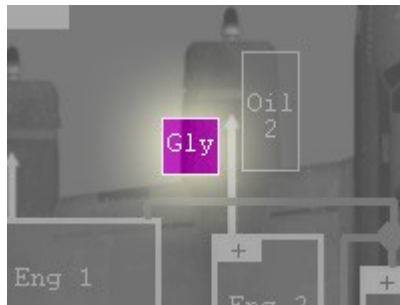
Reserve fluid is stored in the 1.3 U.S. gallon supply tank located in the top of the number two engine nacelle. If you notice an excessive depletion of hydraulic fluid after a flight, have your mechanic check your aircraft in the maintenance hangar.

### **CAUTION:**

During starting and ground operation of engines, the cabin heat control must be in the "OFF" or "COLD" position to prevent glycol in the system from boiling away.

## Glycol Holding Tank

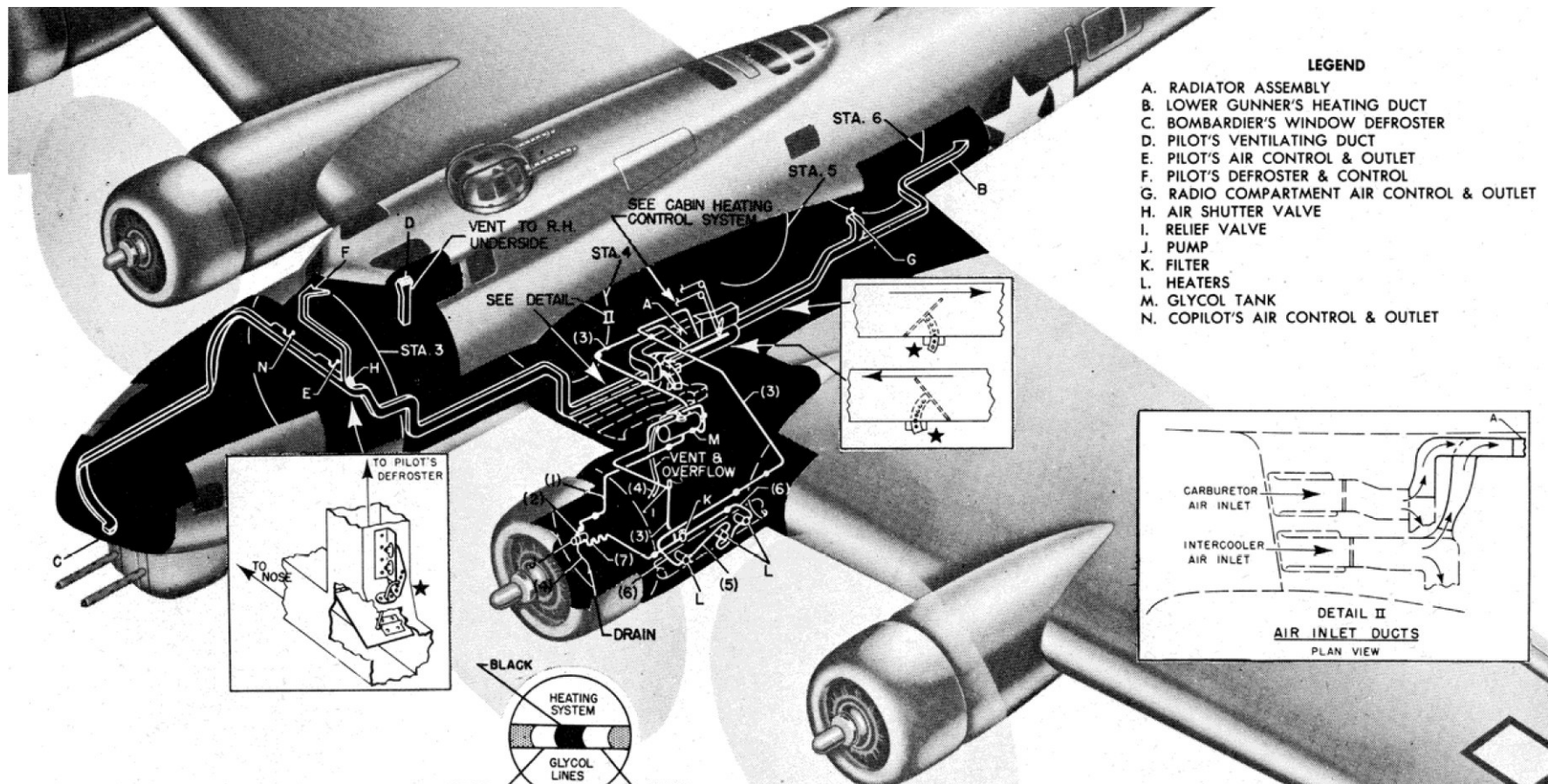
The heating fluid (glycol) holding tank is located inside the #2 engine housing, and it holds 1.3 gallons of fluid. It can be refilled in the FUEL and PAYLOAD MANAGER.



## Heating Fluid Leakage

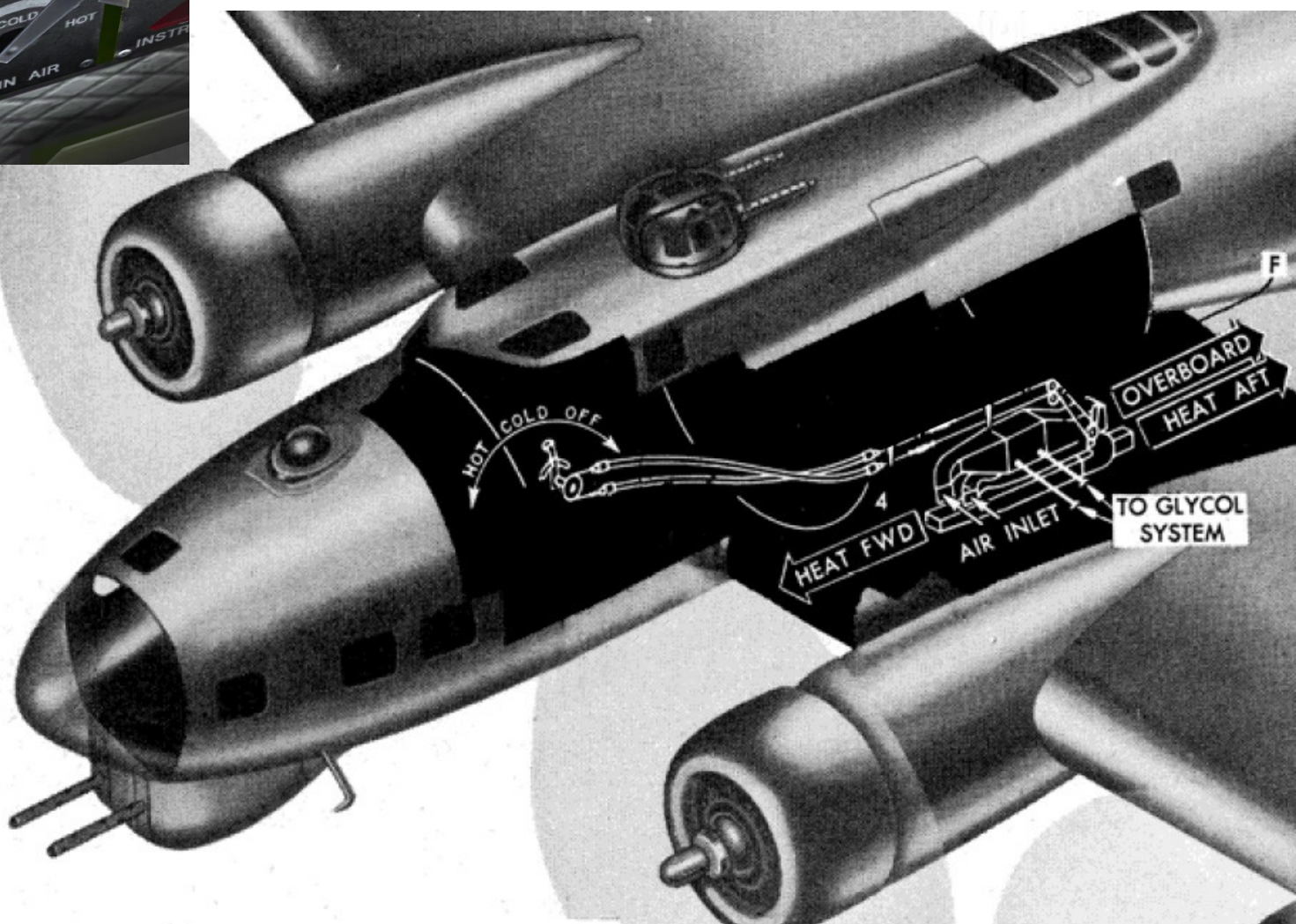
If you notice an excessive depletion of hydraulic fluid after a flight, have your mechanic check your aircraft in the maintenance hangar.

Below is a diagram showing you how the exhaust stack in engine two heats up the glycol fluid and air is heated from a glycol filled radiator. You can see the duct work to the nose, cockpit, radio room, and waist area (no heated air for the tail gunner).





This diagram shows you the direct linkage from the pilot's cockpit cabin air lever. The aft / forward heat distribution is set at the factory, so this cockpit lever acts as a global controller.



# Braking System

## Overview

Bringing a 50,000 pound machine to a stop from over 100 mph takes a tremendous amount of power, and most importantly, produces heat. If you drive a car, you have probably been told once in your life that it is not good to stay on the brakes for a long period of time (don't "drag" your brakes down a hill). It is, in fact, better to pump the brakes because the brief moments between braking allows for more cooling.

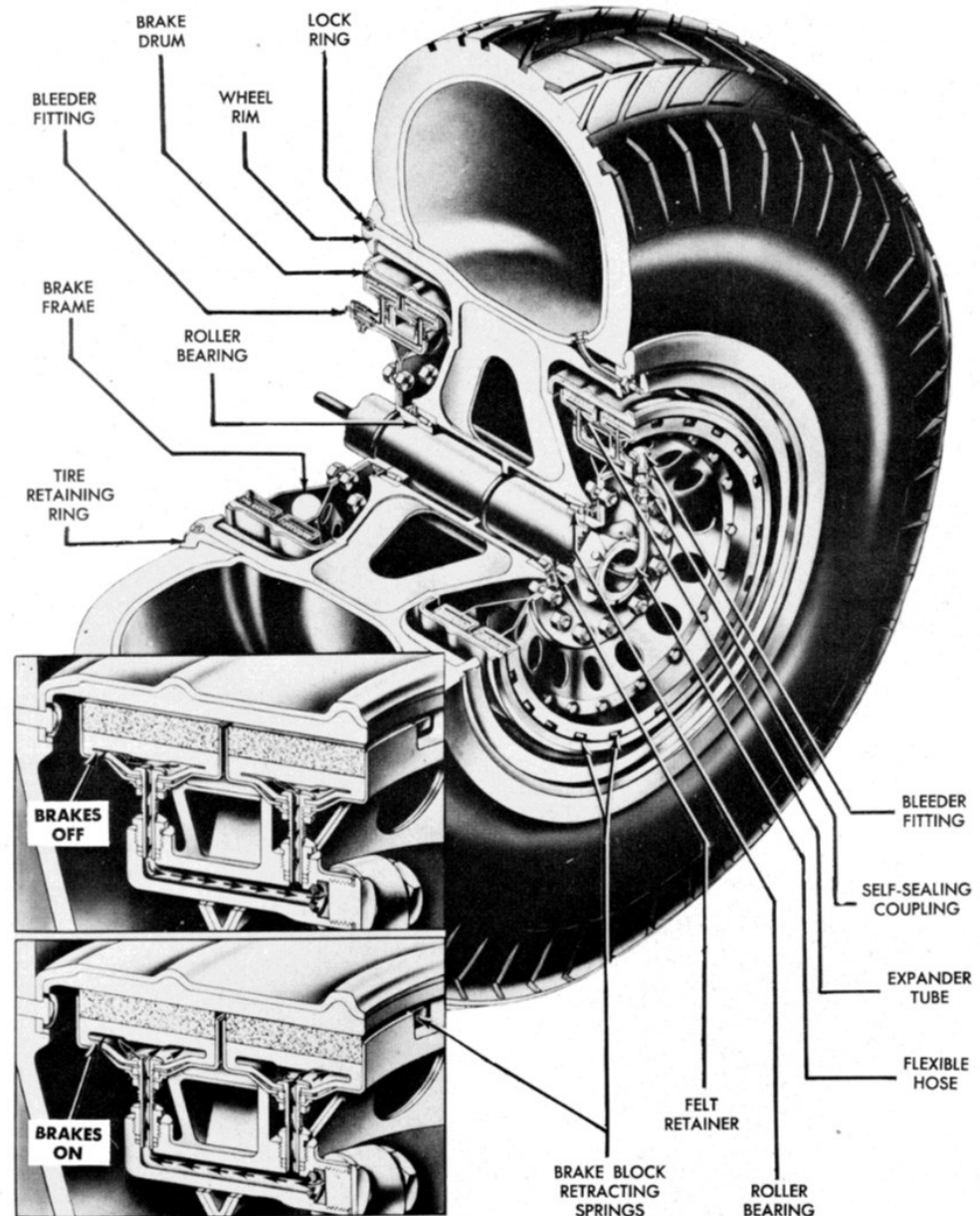
However, even with perfect braking technique, by the time your aircraft has entered the taxi way, you must know that your brakes are hot. So use proper taxiing techniques that will avoid further use of the brakes.

**WARNING:** Do not apply constant brake pressure to hot brakes when still.

## Parking Brake

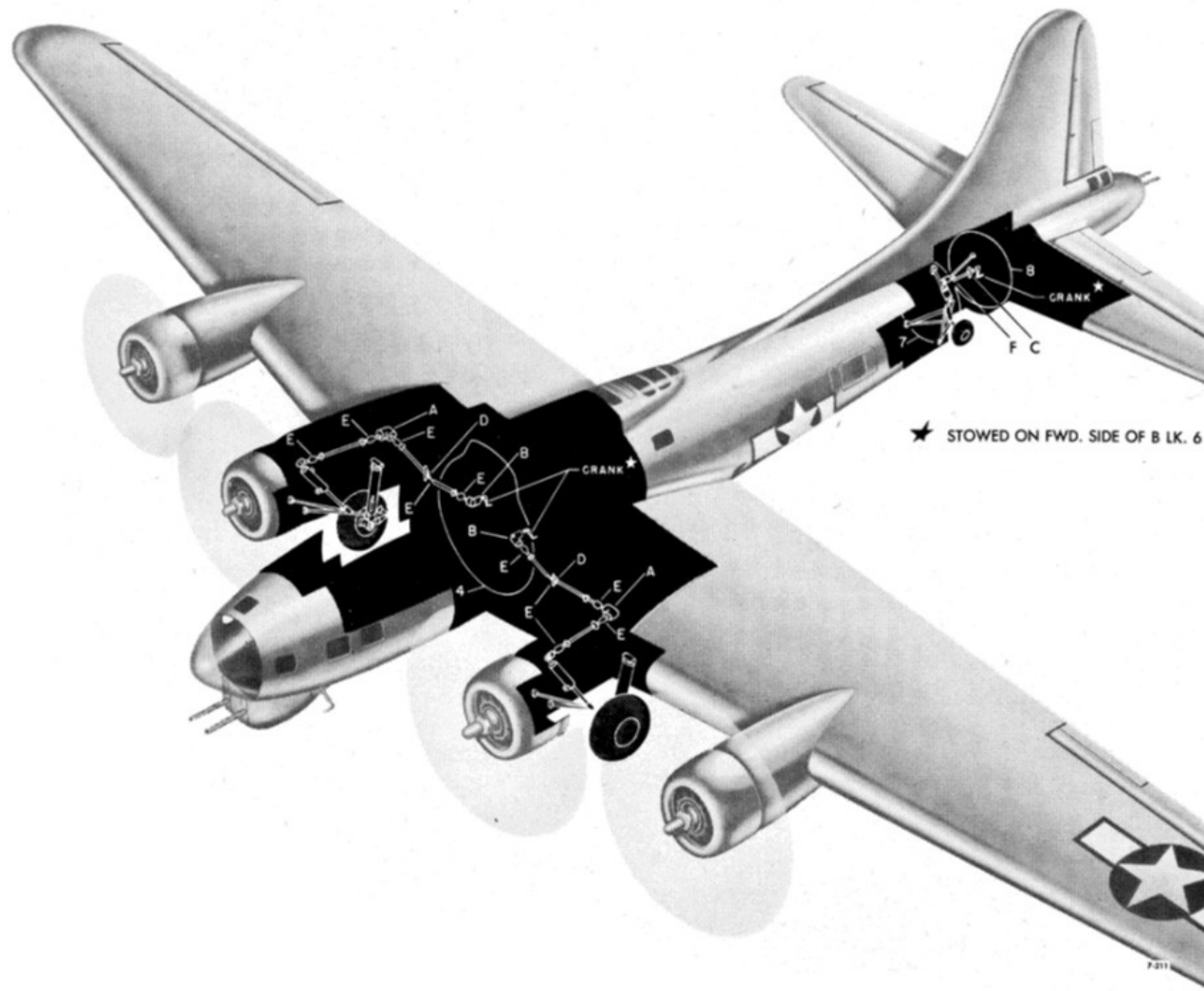
The pull handle at the bottom of the instrument panel on the co-pilot's side controls the parking brake. This utilizes the regular braking system, therefore, hydraulic pressure must be available when the parking brake is required for any length of time. When necessary, set the parking brake handle and pump the system pressure to at least 400 pounds per square inch (minimum pressure for full braking control).

**WARNING:** Do not set parking brake while brake drums are hot.



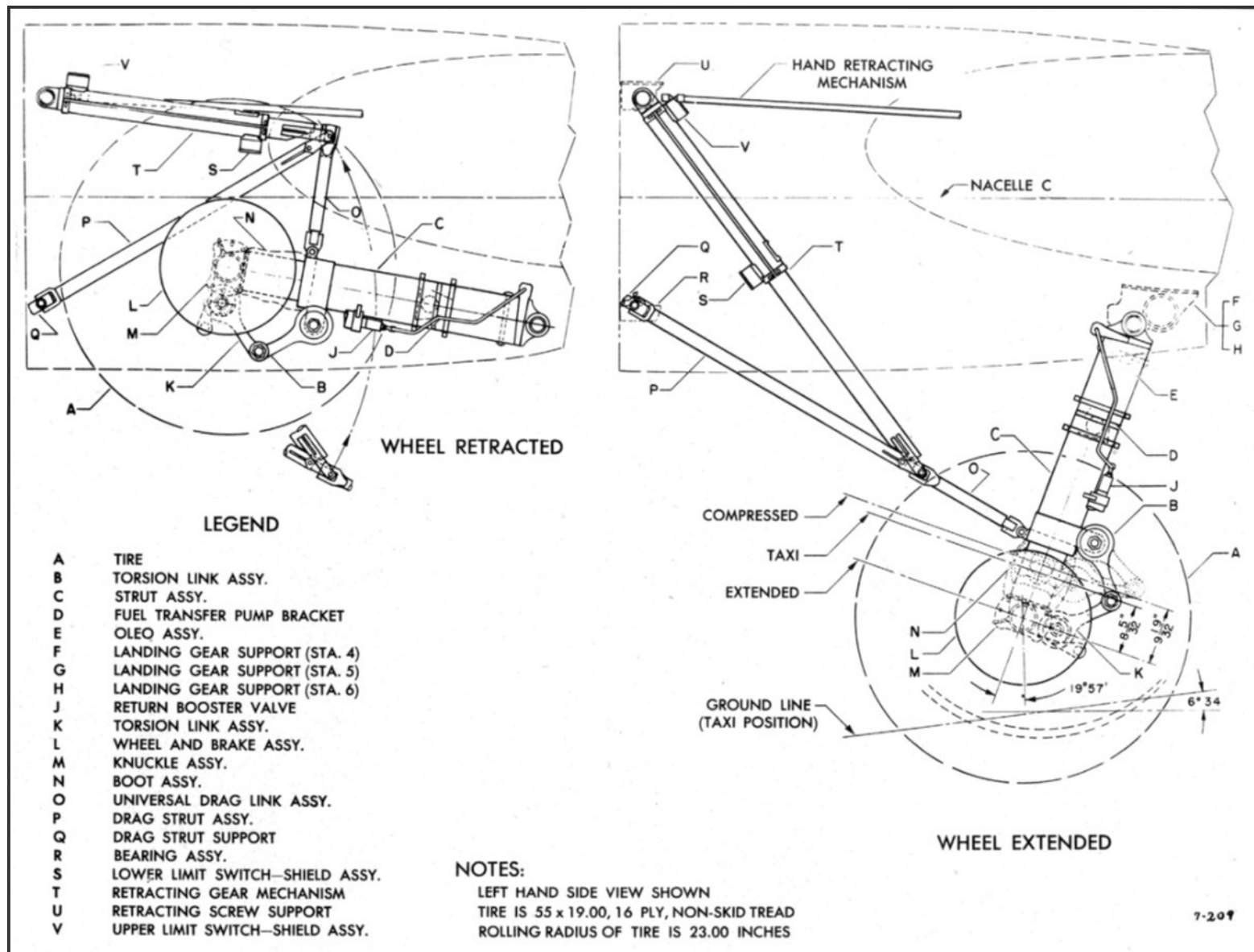
## Landing Gear System

Do not lower your landing gear if you are above 200mph IAS (indicated airspeed). Moving the gear under these speeds can put too much strain on the electric gear motor. If your motor fails in flight, you can order your crew to hand crank the gear up or down. Be aware, they crank one wheel at a time, and it is a slow, tiring process. Also, it is possible that the linkage is broken between the hand cranks and the landing gear, in which case there is nothing you can do to raise or lower your landing gear.



Landing Gear Retraction Diagram

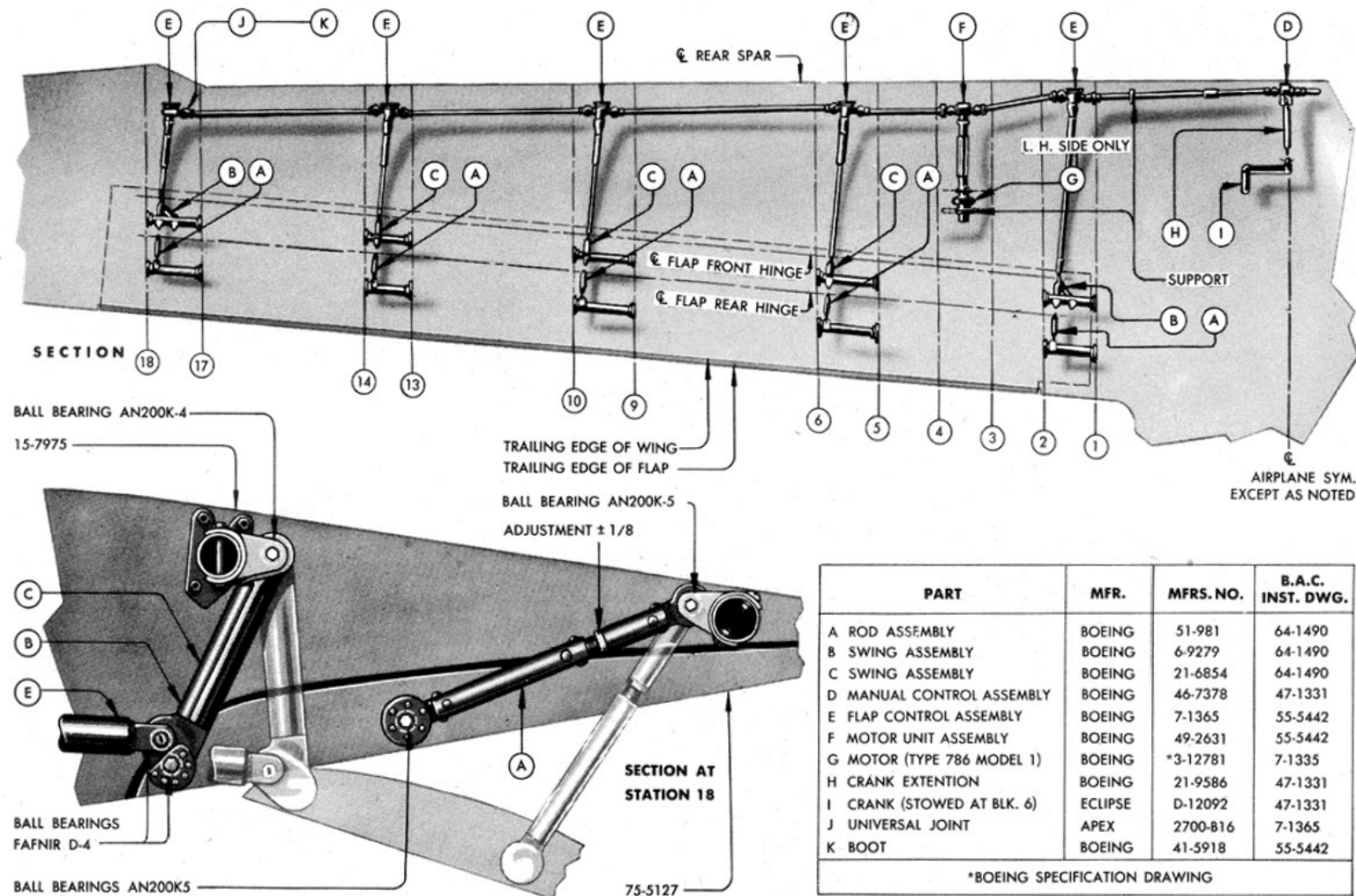
Below you can see the extension and retraction of the tail wheel gear assembly. This also is controlled by an electric motor, and can also be hand cranked if the motor fails. The tail gunner will confirm when the tail wheel is fully extended or retracted.





## Landing Flaps System

Do not lower your flaps above 147mph IAS as lowering flaps places a lot of strain on the electric flap motor. The increased pressure on the flaps increase exponentially with airspeed, so lower your flaps gradually and at proper speeds. Flaps can also jam, which will typically lock both flaps as the system operates together.

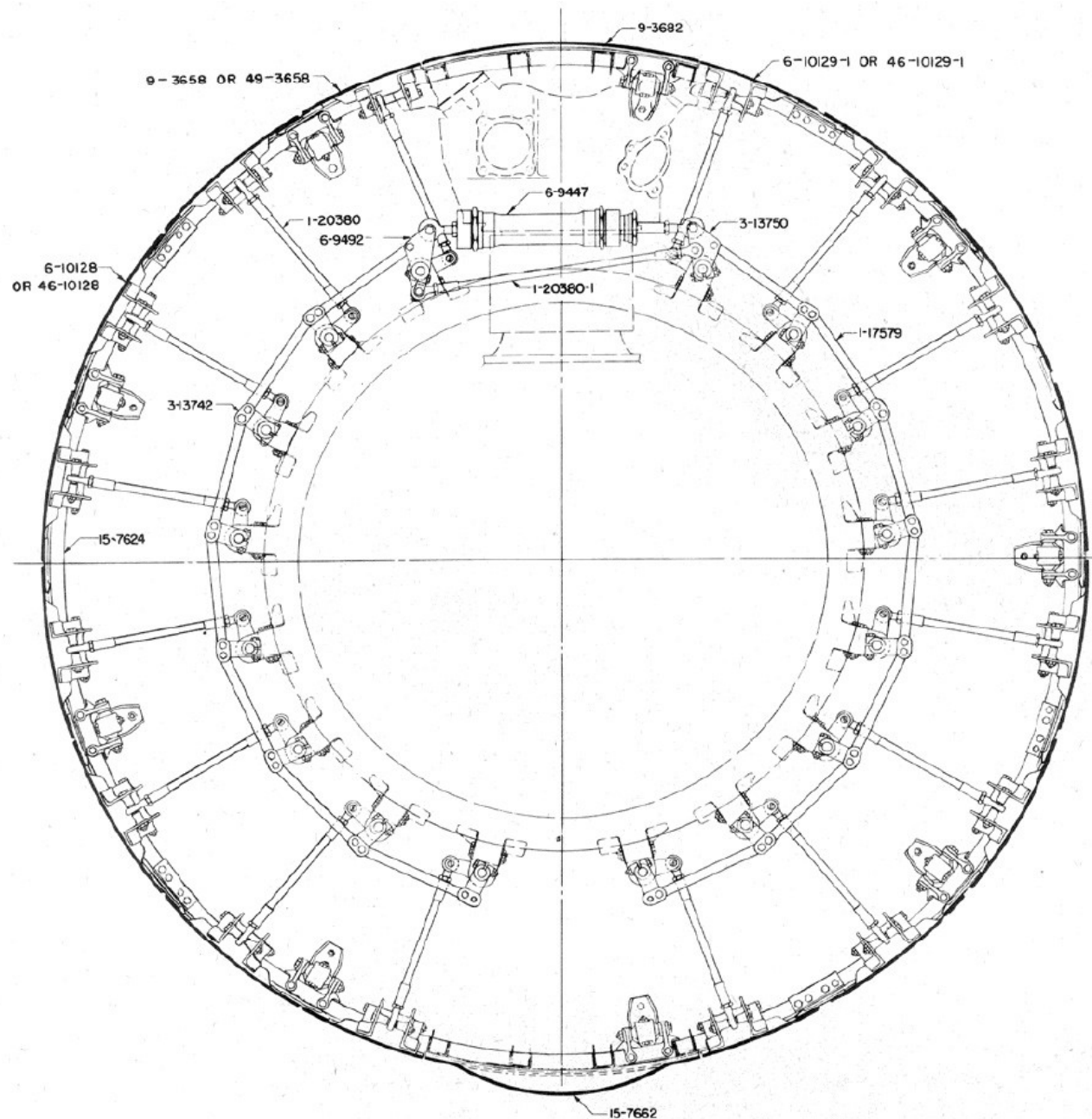


Wing Flap Mechanisms

## Cowl Flaps System

Just like any flap, you must be cautious and aware of the speed at which you are extending a flap into the stream of air. At some point, the flaps can produce turbulence and strong drag and forces on both the actual flap and airframe. Extending cowl flaps at too high a speed can force the weaker, internal components to bend or buckle, in which case your cowl flaps will not be able to reach their full extension. A good rule of thumb is to set your flaps at 50% at takeoff and keep them at 50% or less in flight, and 100% on the ground or taxiing.

You can see how the linkage for the cowl flaps is designed and where the weak links will give under extreme pressures.



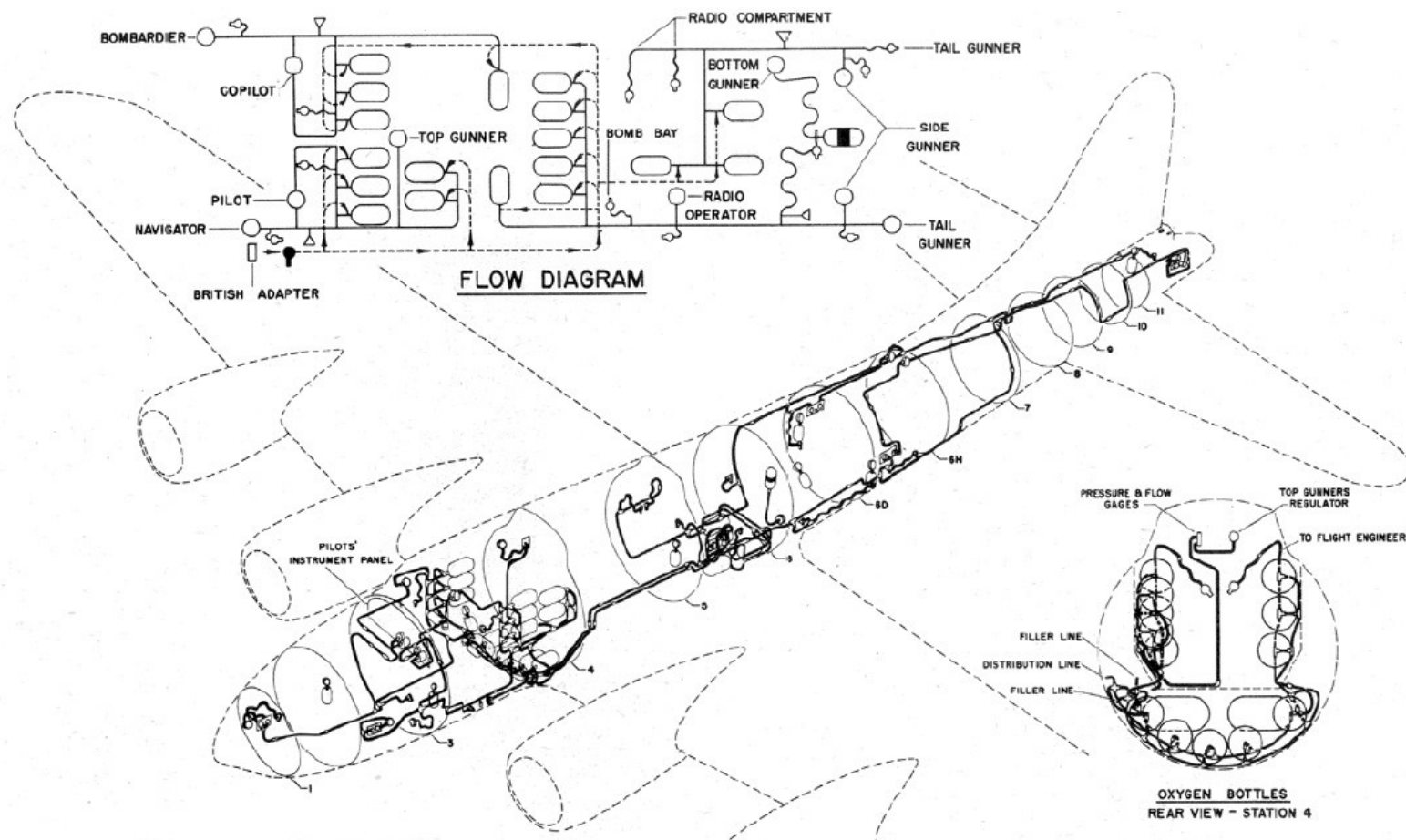


## Oxygen System

Breathing oxygen is stored in type G-1 cylinders and is distributed by four self-contained systems. The main system is filled to 400 pounds per square inch pressure through a filler valve just aft of the forward entrance hatch.

The higher the altitude, the thinner the air, and the less oxygen available for each breath you take. Without an oxygen mask, above 12,500 feet you can start to feel the effects of hypoxia (oxygen starvation). Hypoxia is very dangerous as it can sneak up on a pilot without him realizing, and render him unconscious. As you gain experience as a pilot, you learn to notice these signs.

Accu-Sim has secret and subtle ways to let you know you are starting to experience hypoxia. At some point, you may notice your breathing is heavy. If this happens, make sure your oxygen is working properly. If not, **IMMEDIATELY** dive to lower altitudes. If you end up not responding to these signs and pass out, you will lose complete control of the aircraft. Only when you return to lower altitudes will you awaken.



## Trim Tabs

### Aileron Trim

Complete aileron tab travel requires about 3-3/4 turns of the knob located on the pilot's floor panel.

### Rudder Trim

Complete rudder tab travel requires about seven turns of the wheel located on the floor in front of the control pedestal.

### Elevator Trim

The elevator trim tab wheel on the left side of the control pedestal requires about six turns for complete travel. It has a friction brake to prevent creeping.

## Control Locks

### Aileron Lock

The aileron is locked in the neutral position by a pin which is manually inserted in a hole in the left control column, holding the center spoke of that wheel in a padded slot. The pin is clipped to the pilot's control column when not in use.

### Rudder and Elevator Lock

The locking lever, which is recessed into the floor aft of the engine control pedestal, locks the rudder and elevator when in the **UP** position.

### Tail Wheel Lock

The tail wheel locking lever, which is recessed into the floor aft of the control pedestal, operates a single cable and locks or unlocks the tail wheel. Pull the latch up to unlock and push **DOWN TO LOCK**.

A red warning light on the co-pilot's front panel will light up for takeoff and landing when the tail wheel is **UNLOCKED**.

## Other Systems

### Propeller Anti-icer Control

A toggle switch on the side wall controls the two propeller anti-icer pumps. Two rheostats on the floor panel control the speed of the pump motors and may be used to turn the motors off if desired. Normally the rheostats should be left adjusted to a predetermined rate of flow and the pump motors turned on or off by means of the toggle switch.

### Alarm Bell

A toggle switch in the pilot's electrical panel operates three alarm bells, one under the navigator's table, one above the radio operator's table and one in the tail wheel compartment.

### Landing Gear Horn Reset

A switch on the control panel permits the silencing of the landing gear warning horn when it is desirable to continue flight with one or more throttles closed. Operation of this switch does not prevent repetition of the warning for subsequent closing of any throttle while the landing gear is up. The switch is reset when the throttles are opened. The landing gear horn has been removed from this aircraft.

## Normal Operations Checklists

### Entering Cabin

1. Check weights and fuel.
2. Set the parking brakes.
3. Flaps and gear "NEUTRAL".
4. Check freedom of controls.
5. Check each battery separately with inverter ON.
6. Turn on all three master battery switches.
7. Start APU if necessary.
8. Check hydraulic pressure (use MANUAL if under 200psi).
9. "OPEN" cutoff switches for all engines.
10. Set air filters to "FILTERED" position.
11. Cabin heat "OFF" or "COLD"
12. Master Ignition "ON"

## Engine Start

(Starting sequence 3,4,1,2)

1. Manifold pressure selector to "0"
2. Sequence for starting Engine #3
3. Magnetos "BOTH".
4. Fuel Boost "ON" (Check fuel pressure is 6-8 psi on copilot's panel).
5. Mixture "AUTO-RICH".
6. Open cowl flaps, set to LOCKED.
7. Crack throttle.
8. Propeller HIGH RPM.
9. Set fire extinguisher to engine being started.
10. Select START, wait 12 seconds
11. While in START position, give one shot of primer then select MESH.
12. When the engine is meshed (turning), continue to prime until engine fires.
13. After engine starts, idle at 1,000 RPM, check oil pressure.
14. Turn on the Generator switch for the engine that has started.
15. Repeat steps 3-14 for Engines 4, 1, and 2.

When engines are thoroughly warmed (40 deg oil temperature), rpm may be increased for instrument check.

2,500 rpm must not be maintained for more than 30 seconds and the following values must not be exceeded:

- Fuel pressure 16 lb/ sq in.
- Oil pressure 80 lb/ sq in.
- Oil temperature 190°C
- Cylinder temperature 235°C

#### Engine Accessories Ground Test

1. Set altimeter.
2. Hydraulic pressure should be 600 to 800 psi. If hydraulic pressure is under 200 psi, hold hydraulic pump switch on pilot's electrical panel on MANUAL until 200 psi is reached, then release switch (spring loaded switch will return to AUTO).
3. Check all engine generators and batteries are ON.
4. Tail wheel unlocked (red light)
5. Landing gear (green light)
6. Set propellers to HIGH
7. Check fuel quantities
8. Intercoolers COLD
9. Flight controls UNLOCKED
10. Wing flaps UP
11. With mixture controls in AUTO-RICH, check the following during ignition check:
12. Check ignition at 2,000 rpm (rpm drop no more than 200 rpm from two magnetos to one)
13. Fuel pressure 12 to 16 psi



14. Oil Pressure 70-80 psi
15. Oil Temperature 88°C MAX
16. Cylinder head temperature 235°C MAX
17. Bring engines back to idle (1,000 rpm)
18. Increase manifold pressure selector to 8
19. Increase to full throttle, one engine at a time. Verify each engine is producing 45" manifold pressure. Adjust turbo trim pots if necessary. If adjustments are necessary, these must be made quickly (30 sec max) to avoid exceeding maximum cylinder head temperatures. If necessary, allow the engine to idle and cool off while testing other engines.

### Takeoff

1. Lock tail wheel
2. Flaps UP
3. Cowl flaps 1/3
4. Oil Temp 40 deg C MIN / Cylinder Head Temp 205 deg C MAX.
5. Set turbo to 8 (7 for 91 octane fuel).
6. Open throttles slowly to full throttle (with runaway turbo, THROTTLE BACK FIRST then move manifold pressure selector to "0").
7. When clear of ground, raise landing gear.
8. Accelerate to climb speed (135-150 mph).

Apply power smoothly and gradually, walking the throttles forward evenly until reaching full takeoff power in the first 1/3 of the runway. The aircraft will have a moderate tendency to pull to the left; use right rudder or differential throttle to correct. Good rudder control is achieved by 80 mph IAS. Allow the tail to lift naturally. Take off from a two-point, tail-low attitude. The aircraft will fly itself off the runway at about 115 mph with just moderate back pressure on the controls, depending on gross weight. Retract gear as soon as a positive rate of climb is established. After reaching 140 mph IAS reduce power to rated power (38" Hg and 2300 rpm). Retract flaps before reaching 150 mph IAS. Hold the aircraft in a very shallow climb until an indicated airspeed of 150 mph is achieved.

### ***Takeoff Over 50 ft Obstacle***

Weight, pounds	Distance, feet
62,000	4,190
62,000	2,850*

\*Three-point takeoff using 1/3 flaps and full war emergency power: full throttle and 2,760 RPM. Emergency / Short Field Takeoff

For short field takeoff, the manifold pressure may be set to the maximum war emergency setting of 55" (manifold pressure selector 10) and the propeller governor control may be set to 2760 RPM. These represent the maximum possible propeller and throttle settings. Use 1/3 flaps and use a three point takeoff technique, climbing at full war emergency power. Do not use war emergency power for more than two minutes.

### ***Engine Failure During Takeoff***

Failure of an engine during take-off may not be noticeable immediately except for a resultant swing. If, therefore, a swing develops, and there is room to close the throttles and stop, this should be done.

If it is necessary to continue with the take-off, even though one engine has failed, hold the airplane straight by immediate application of rudder. Gain speed as rapidly as possible. See that the landing gear is up, or coming up, and feather the propeller of the dead engine. Re-trim as necessary.

### Climb

1. Reduce manifold pressure with turbo dial.
2. Reduce RPM as required.
3. Set cowl flaps to maintain a desired 205 deg C cylinder head temp.
4. Adjust trim as required.
5. Close air filters above 8,000 feet.

Climb at an indicated airspeed of 140 mph IAS (150 mph IAS if on instruments) with a power setting of 38" of manifold pressure and 2300 rpm. For lower weights use 35" and 2300 RPM. Cowl flaps are normally set to about 1/2 open or less for climbing. Maximum cylinder head temperature is 218 degrees Celsius. This aircraft was equipped with an automatic mixture control. Therefore, no mixture adjustment is necessary.

### Level Flight

1. Use full throttle, set power with turbo (4"-6").
2. Mixture "AUTO-LEAN".

The B-17 must cruise "on the step" in order to get the maximum possible range. To get "on the step" climb to at least 500 feet above your desired cruising altitude and allow the aircraft to accelerate to cruising speed while descending to the cruising altitude. Normal cruising speeds for the B-17 are 140-150 mph IAS depending on the aircraft weight and altitude. The aircraft will cruise in a slightly nose-up attitude at heavier weights and higher altitudes. The maximum cylinder head temperature is 218 degrees, 205 is desirable. This aircraft was equipped with an automatic mixture control. Therefore, no mixture adjustment is necessary.

### Approach and Landing

1. Set mixture to "AUTO-RICH".
2. Air Filters "ON".
3. Turbo "8" ("7" for 91 octane fuel).
4. Lower landing gear.
5. Check brakes.
6. Check hydraulic pressure (600-800psi).
7. After speed is below 147mph, lower flaps.
8. Adjust trim as required.

Calculate the power-off stalling speed based on the aircraft weight. Set engines to 2100 RPM and adjust power as required to achieve an airspeed of 140-150 mph IAS. Enter the pattern at either the crosswind or downwind leg at 800-1000 feet AGL. If possible, enter the pattern on the crosswind leg and fly 2-3 miles out from the runway. This will provide ample room to maneuver the aircraft. Turn base 2-3 miles beyond the runway threshold at 145 mph IAS and lower flaps to 1/3 down and reduce airspeed to 135 mph IAS. Maintain a constant altitude on the base leg. Turn on final at this airspeed. Once on final approach, move the propeller controls to the takeoff position (2500 RPM) using the prop governor gauge as a reference. Do not lower the flaps fully until the runway is made. Maintain a glide speed of about 120 mph IAS for the final approach. Pick a point about ten feet in front of the runway threshold and line this up with the end of the nose to set the correct glide path. A normal final approach is made with 20" of power at 120 mph with a descent rate of 500 fpm. Make a three-point landing, gliding onto the runway at this speed.

## **Emergencies**

### **Emergency Operations of Landing Gear**

Each main landing gear may be operated separately by means of a hand crank connection in the bomb bay. If the landing gear motor has failed, you can instruct your crew to hand crank the gear either up or down. They will crank each main wheel and the tail wheel independently. If the landing gear linkage is damaged, it is possible that it still will not be able to be lowered or raised with a hand crank.

### **Emergency Operations of Landing Flaps**

The landing flaps may be operated separately by means of a hand crank connection in the radio compartment. If the flaps motor has failed, you can instruct your crew to hand crank the flaps either up or down. If the flaps do not move due to high stress forces and are subsequently jammed, hand cranking may not be possible.

### **Emergency Bomb Release**

An emergency release handle is located at the pilot's left. Pull the handle to release whatever is in the bomb bay (bombs or bomb bay fuel tanks). Make sure the bomb bay doors are opened before pulling this release handle.

### **Engine Fire in Flight**

1. Close the fuel shut-off valve for the engine affected
2. Feather the prop immediately.
3. Slow the air speed as much as possible
4. Close the cowl flaps
5. Set the fire extinguishers on the co-pilot's side to the engine on fire and pull the CO<sub>2</sub> handle.

**CAUTION:** Leave propeller feathered. Do not attempt to restart the engine while hot.

## 2D PANELS

### Crew's Reports (SHIFT-2)

*Important information is readily available within the Crew's Reports screen.*

**Ground Speed** is the actual speed your aircraft is moving over the ground surface.

**Cabin temp** will show the general temperature of your cabin.

**Estimated endurance** is the amount of time your aircraft can fly at the current rate of fuel consumption. Take into account, as you are climbing to your cruise altitude, this estimated endurance will be less than once you level off, throttle back, and settle into a cruise.

**Estimated range** is the distance your aircraft will fly at the current speed and rate of fuel consumption. Again, take into account this will change based on climb, cruise, and descent operations.

**Distance to Sea Level** (not displayed) is only displayed when your aircraft is in a descent. This can help you establish a steady descent. For example, if you are 100 miles out from your destination, you would descend at a rate that would put you on the ground at 100 miles. This is a sea level calculation, so take into account your airfield height when using this calculation.

**Systems to Watch** displays the hottest engine temperature and general warnings.

**Power Settings** represent your clipboard showing you important info to quickly establish a proper takeoff, climb and cruise.

**Notes** contain five pages of important things to remember and abbreviated checklists.

The screenshot displays the 'Crew's Reports' interface with a 'transparency + -' toggle. It is divided into several sections: a top status area, a 'POWER SETTINGS' table, a 'NOTES' section with a list of operational tips, and a bottom section with three columns of checklist items labeled 'ELECTRIC', 'HYDRAULIC', and 'VACUUM'. A note on the right side explains that settings change based on fuel grade, and an arrow points to a 'page 1' navigation button at the bottom right.

**Crew's Reports** transparency + -

Ground speed: 0 mph Cabin: 68°F 20°C

Est. endurance: 30 h, 0 min  
Est. range: 0 NM

Systems to watch:  
Engine 1 is 170°C

POWER SETTINGS		100 OCTANE FUEL	
Take Off			
46"	2500RPM	Auto-Rich	560gph
Climb (135mph IAS)			
38"	2300RPM	Auto-Rich	480gph
35"	2300RPM	Auto-Rich	400gph
Cruise			
34"	2200RPM	Auto-Rich	350gph
150mph IAS		Auto-Lean	122-188gph

**NOTE:**  
These settings will change based on the fuel grade you have loaded.

**NOTES:**

- Avoid pivot turns
- Min 40° oil temp before takeoff run
- Power UP: Mixture, prop, throttles, turbo
- Power DOWN: Turbo, throttles, prop, mixture
- Avoid high power with low RPM
- Carb Ice: Increase turbo boost, lower throttle
- Over 10K: Oxy ON, Air cleaners OFF

<u>ELECTRIC</u>	<u>HYDRAULIC</u>	<u>VACUUM</u>
Avionics	Brakes	Wing Deicer
Gear, Flaps	Cowl Flaps	Gyro Instr.
Bomb Bay		
Hydraulic Pump		
Turbo control		

You can access handy checklists by clicking here.

< page 1 >



## Controls (SHIFT-3)

Manage your crew and have quick access to various systems

In the CONTROLS screen, you can:

Order bombardier to drop whatever is in the bomb bay (bombs or fuel tanks).

Order waist gunners to crank damaged landing gear or flaps up or down.

Lock controls.

Order waist gunners to start or stop the APU (Auxiliary Power Unit).

Put headphones on to hear crew better.

Manage electrical system and interior / exterior lights.

Manage cowl flaps and intercooler flaps (can gang together).

Order co-pilot to manage the RPM, cowl flaps, or intercooler flaps.

Repeat the last call.

Auto-start all engines.

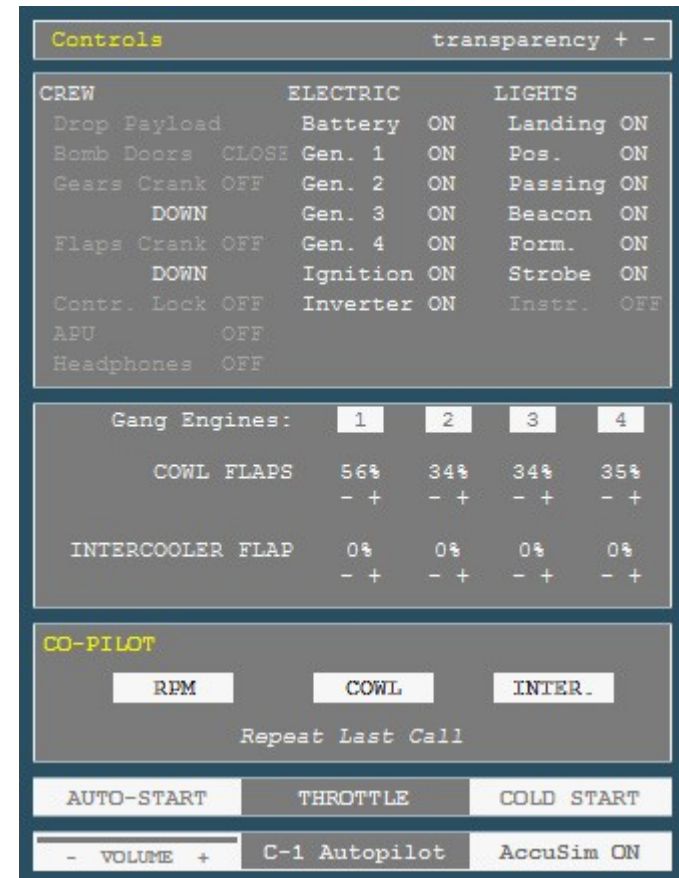
Set aircraft to cold start (enter aircraft after it has been idle for 8+ hours).

Manage your throttles or turbo with controller axis.

Adjust Accu-Sound volume.

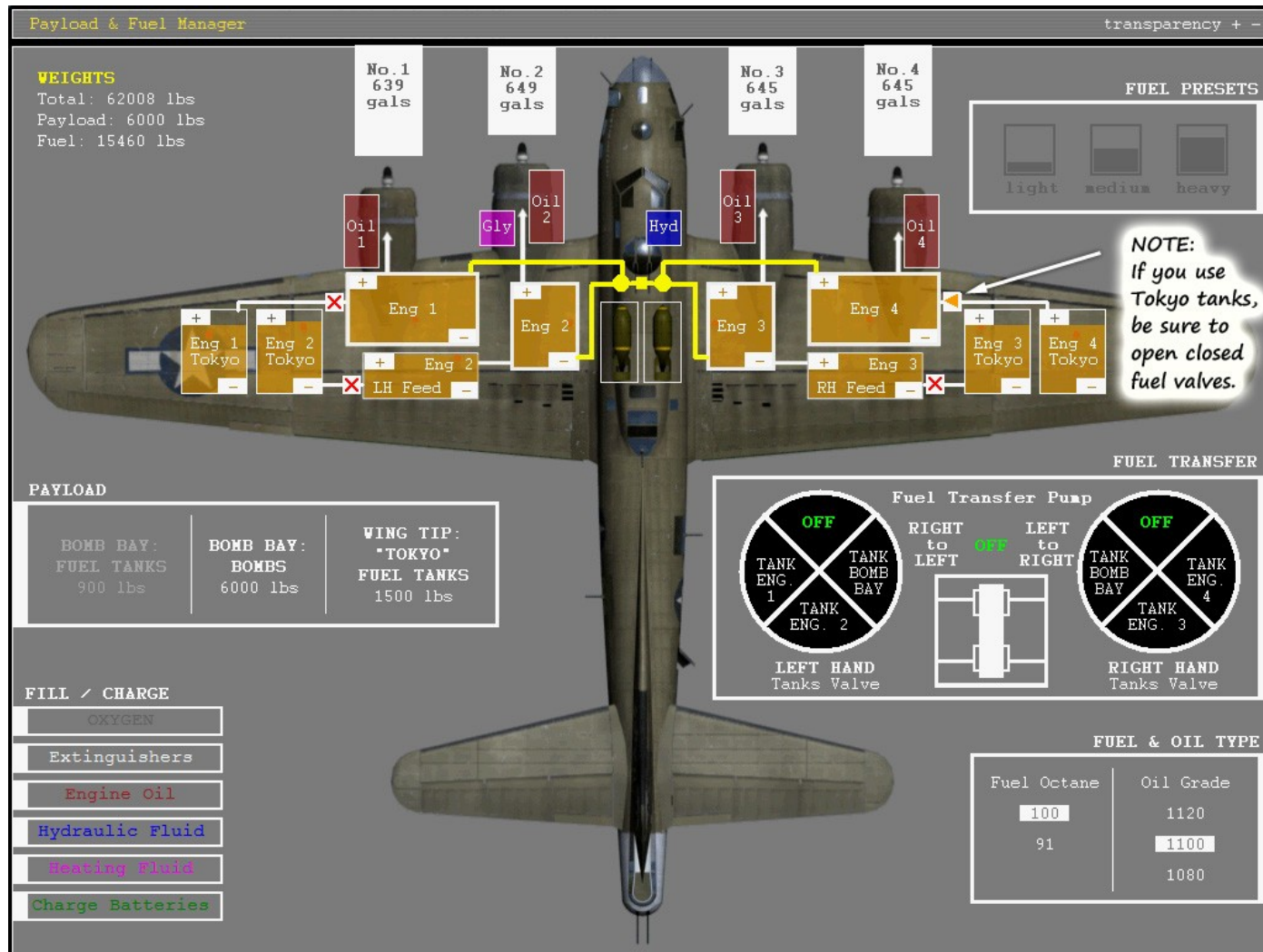
Select either C-1 Autopilot or stock FSX autopilot.

Turn Accu-Sim master control ON or OFF.



## Payload and Fuel Manager (SHIFT-4)

This powerful menu allows you to fill any fuel tank, load bomb bay tanks (or 6,000lb of bombs), install “Tokyo Tanks” (extra long range tanks in the wings) and use the fuel transfer pump to transfer fuel between tanks. You can also check and refill your engine oil, hydraulic fluid, glycol (cabin heating fluid), oxygen tanks, fire extinguishers, and charge batteries. Fuel octane and oil grades can also be selected.



### Fuel Level

Fuel tanks are shown in the approximate locations with the amount of fuel shown. You can add and subtract fuel by directly clicking on the desired fuel tank.

### Fuel Transfer Pump

See FUEL SYSTEM for details.

### Engine Oil Levels

Oil tanks are shown in the approximate locations with the amount of oil shown. You can fill all tanks by clicking on the REFILL OIL button on the lower left. See OIL SYSTEM for details.

### Hydraulic Fluid

The hydraulic fluid holding tank is shown over the rear portion of the cockpit. You can fill the tank by clicking on the REFILL HYDRAULIC FLUID button on the lower left. See HYDRAULIC SYSTEM for details.

### Heating Fluid

The glycol fluid holding tank is shown over the #2 engine. You can refill the tank by clicking on the REFILL HEATING FLUID button on the lower left. See HEATING SYSTEM for details.

### Fire Extinguishers

If your fire extinguishers were depleted in flight, they can be re-filled by clicking on the Extinguishers button.

### Fuel Type

You can load your aircraft with either 100 or 91 octane av-gas. See USING DIFFERENT TYPES OF FUEL for requirements.

### Oil Grade

You can load three different types of oil, 1120, 1100, and 1080. See USING DIFFERENT TYPES OF OIL for requirements. Use higher numbers in higher temperatures.

## Navigator's Map (SHIFT-5)

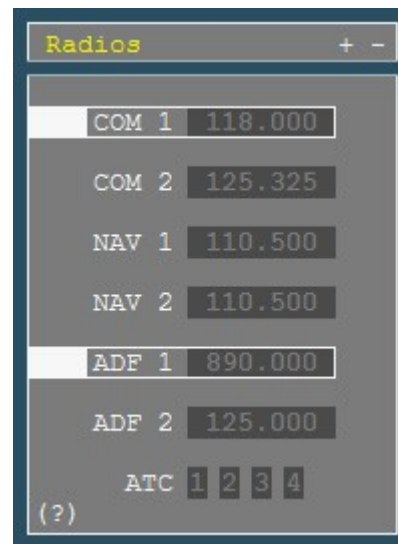
The navigator's map presents the horizontal situation.



## Radios (SHIFT-6)

The 2D radio control panel allows a convenient way to set the frequencies of the radios, select the active transmitter and select a radio navigation source for Radio Compass. The pilots directly operate ADF2 Radio unit only, they can also remotely select the transmitter to communicate. The rest of the radios are controlled by other crew members and this 2D radio panel simulates their work.

The command receiver which controls heading is located on the ceiling panel is not functional due to an unsupported frequency ranges in Flight Simulator.



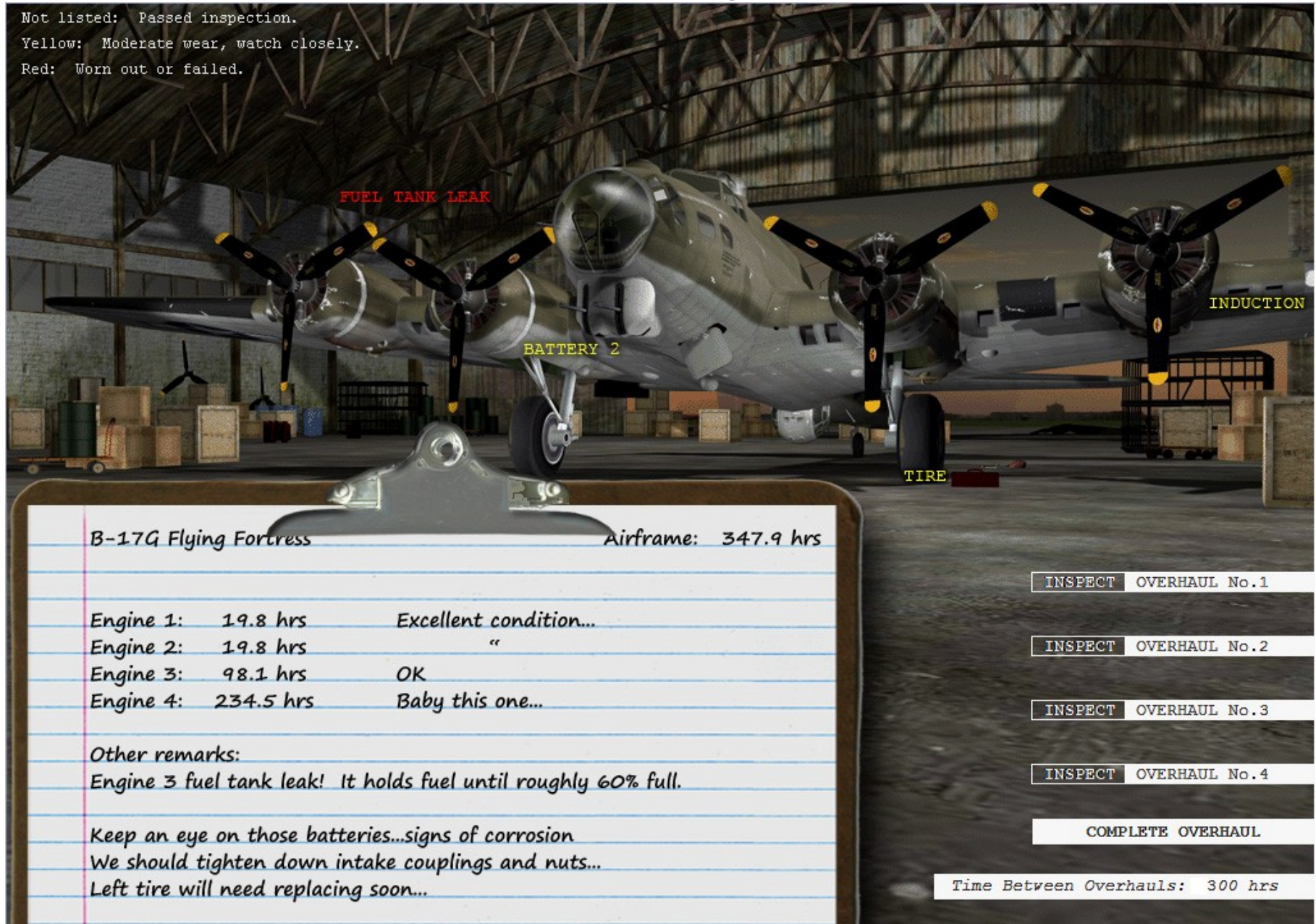


## Maintenance Hangar (SHIFT-7)

Not listed: Passed inspection.

Yellow: Moderate wear, watch closely.

Red: Worn out or failed.



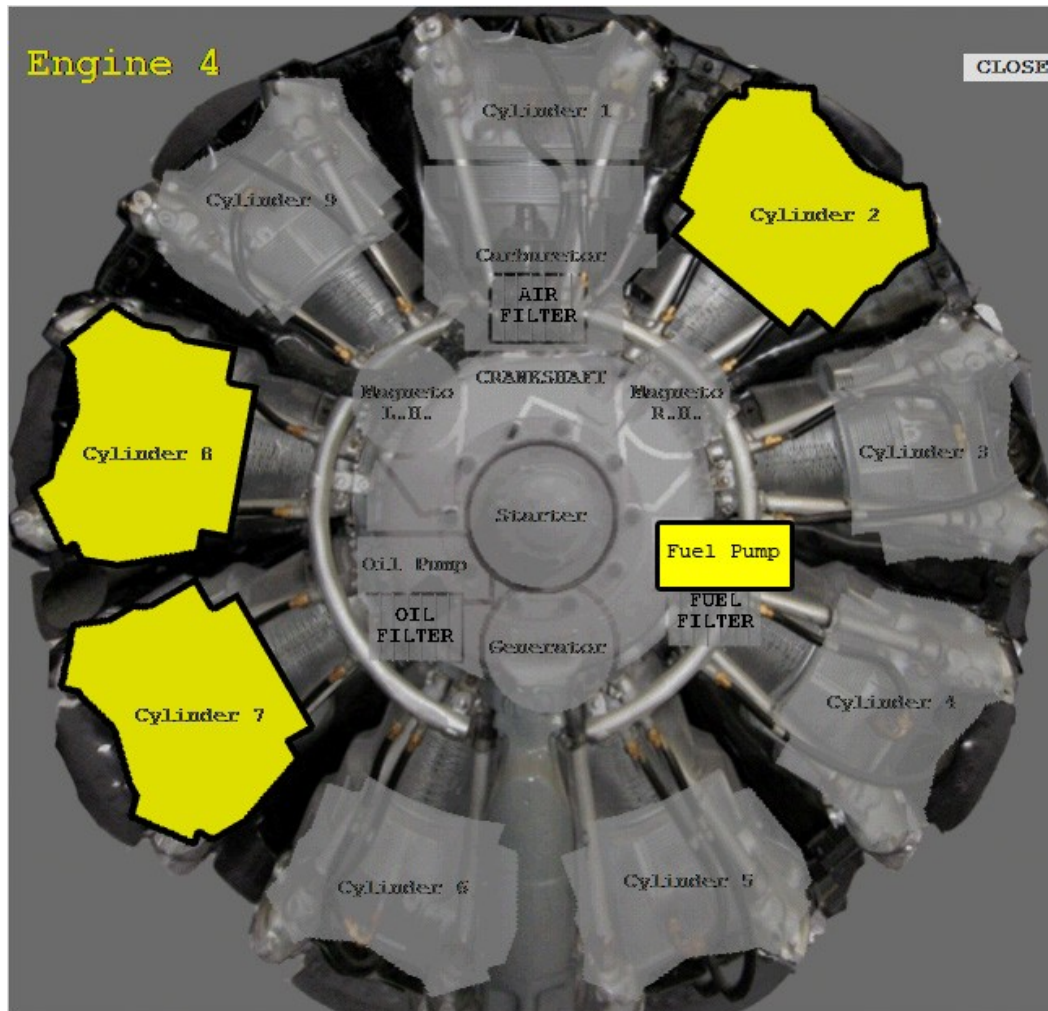


## *The Crew Chief's Clipboard*

Every time your B-17 is pulled into the hangar, your crew chief gathers up any previous notes and reports and inspects the aircraft. Anything he finds worth noting is listed on his clipboard.

### *Inspect Engine*

If something more serious is noticed in one of your engines, your crew chief will recommend a more detailed engine inspection. To inspect an engine, click on the INSPECT in the lower right hand portion of the maintenance hangar.



Here you can see major engine accessories and internal engine component conditions. If the component is gray, that means it appears to be OK. Yellow parts indicate moderate wear and you need to watch these parts closely. Any red component means a part has either failed or is completely worn out.

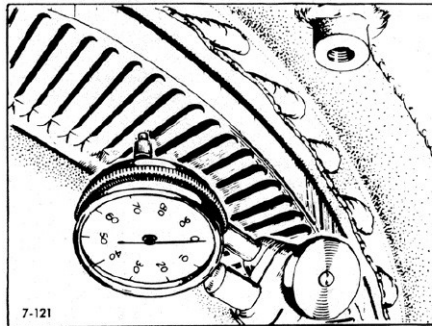
To repair any item, simply click on the item. You will hear a ratchet sound and the part will be replaced.

You can also change your oil, fuel, and air filters in this screen by clicking on them in this screen.

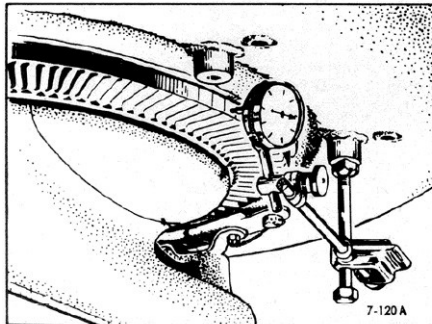
#### **NOTE:**

Repairing the main crankshaft on any motor will result in an automatic complete engine overhaul. If an engine has suffered a worn out crankshaft, usually metal debris in the oil has reached a level where the engine is just pulled off the wing and sent out for a total rebuild or replacement.

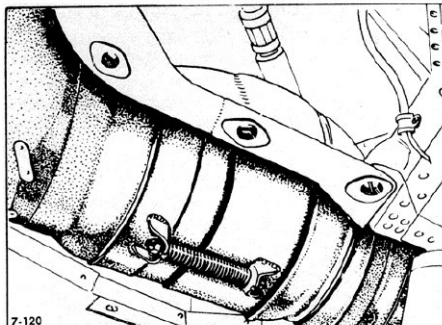
Your crew chief and his crew will perform all kinds of maintenance from checking your turbos to changing various filters throughout the airplane.



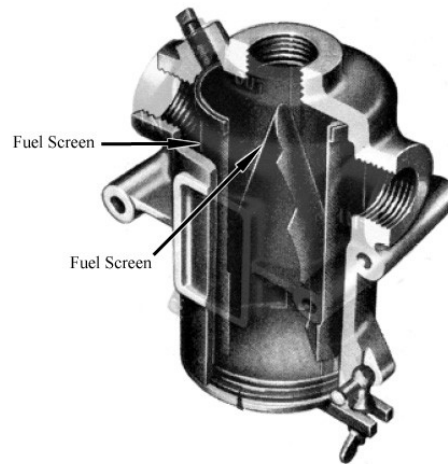
Checking Rotor End Play



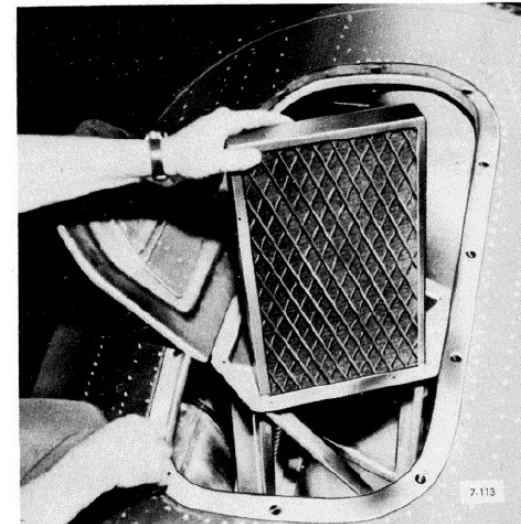
Checking Rotor Side Play



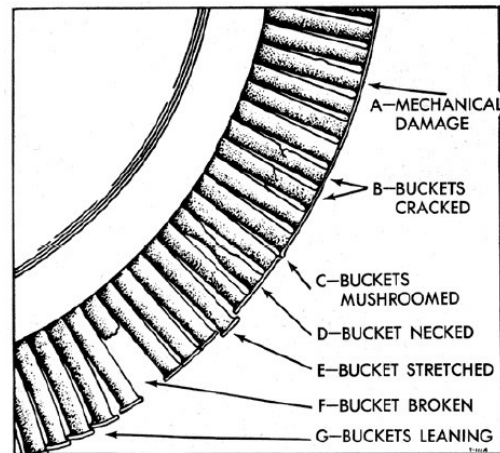
Securing fasteners and connections



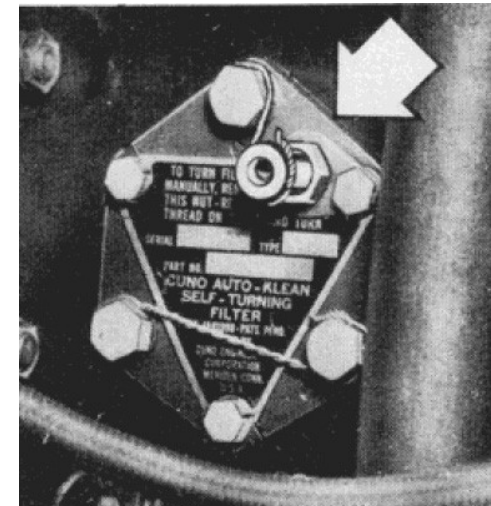
Fuel Filter (strainer)



Carburetor Air Filter Removal and Cleaning



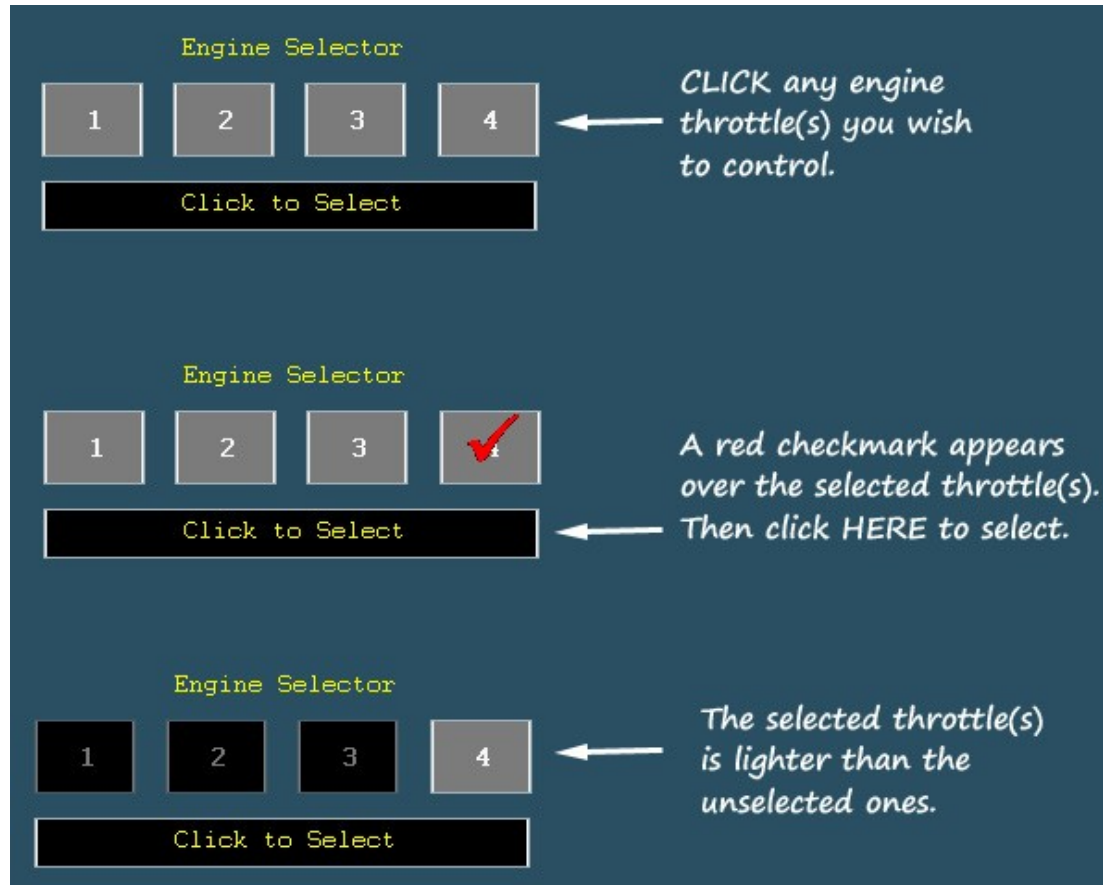
Turbo Bucket Wheel Condition



Oil Filter

## Engine Selector (SHIFT-8)

The Engine Selector panel was designed for those with a single throttle to select and control a specific engine or group of engines. To use, click on the engine number (here shown after clicking on the #4 engine), then click on the “Click to Select” bar below to activate. Once activated, in this example, moving your throttle would control engine #4.



## C-1 Autopilot (SHIFT-9)

The C-1 autopilot can:

- Maintain straight and level flight.
- Keep track of PDI. PDI is controlled by directional stabilizer gyro for straight and level flight, or manually by bombardier.
- Perform coordinated turns ordered by pilot or by bombardier.

C-1 autopilot cannot:

- Do the things mentioned above if the pilot doesn't know how to use it .

How does the C-1 Autopilot actually work?

The autopilot uses two gyroscopes; a vertical flight gyro is used to detect plane pitch and bank and a horizontal stabilizer gyro is used to detect changes in course.

**Note:** A gyroscope is a spinning disk that, due to the equal forces generated by the spinning motion, can detect and measure changes in movement from external forces, such as a plane banking, braking, or accelerating.

When correctly used the C-1 Autopilot will:

- Keep the aircraft wings leveled
- Maintain pitch.
- Try to correct any deviation from a course set when it was engaged.

**Note:** Servo motors are connected to control surfaces, not trim tabs, so it's crucial to trim the aircraft properly before engaging autopilot, otherwise C-1 will have to cope with improper trim.





## C-1 Autopilot Controls

[1] Master / Stabilizer Switch powers the autopilot gyros.

- [2] Channel Switches. Power aileron, rudder and elevator servos.

[3] Servo PDI switch connects the PDI indicator in the cockpit and the torque motor that fights stabilizer gyro precession.

[4] Turn Control Knob is used to perform coordinated turns by the pilot.

[5] Centering knobs adjust control surfaces neutral positions.

[6] Sensitivity knobs adjust the 'dead-zone' before the autopilot orders a correction. Higher sensitivity means more precision, but if it is too high controls will shake due to constant corrections applied by the autopilot.

[7] Ratio knobs control the amount of control surface movement applied for a given deviation. Too high ratio will cause over-steer, too low ratio will cause slow and inadequate response.

[8] Turn compensation further adjusts the control surface movement ratios applied in a turn. These are used to tune the autopilot so that coordinated turns can be made.

[9] Tell tale lights indicate when a control surface position is different from the position required by autopilot. If the aircraft and autopilot are properly trimmed, tell tale lights are off.

[10] Control Transfer. This switch allows to transfer control to second station in navigator compartment. It was optional and this particular airplane is not equipped with second control station, so this switch does nothing.

[11] Bombardier commands. Various commands for bombardier.

PDI [main panel, front] is a gauge that indicates deviation from ordered course. The autopilot always steers the plane to keep the PDI centered (with an exception of turns ordered by pilot with turn knob)



## ***Engagement Procedure***

1. Turn on master switch. [1]
2. Turn on servo PDI switch. [3]
3. Turn on tell-tale lights. [9]
4. Manually trim the airplane for straight and level flight. This is not that important in simulation because there is no proper simulation of forces affecting control surfaces and no force feedback for most users. But it is a good practice anyway and will make the engagement procedure smooth.
5. Center PDI. Autopilot always tries to keep the PDI centered, so if you forget about this step, you will experience a sudden turn as soon as you snap on the engagement switches. There are 2 ways of centering PDI:
  - First and preferred is to tell your bombardier to do so by using the 2D panel [11]. He will then disengage the autopilot clutch that links the autopilot to the horizontal stabilizer gyro, manually move it to center and keep it there until you tell him to stop.
  - If you've forgotten to take bombardier with you on a mission, you can manually steer the plane to the direction the PDI shows.
6. Using aileron centering knob [5] 'trim' the autopilot so that both tell tale lights are off.
7. Turn Aileron Control ON [2]. Check that wings are leveled, adjust with centering knob if necessary. If you fail to do that, cross control will occur and the autopilot will apply rudder to hold banking airplane on a straight course.
8. Using rudder centering knob [5], put out rudder tell-tale lights and engage rudder channel switch.
9. Tell bombardier to release PDI by clicking on a "center PDI" command on 2D panel again [11]. Now directional gyro with correct any deviations from course. Adjust by centering knob if necessary.
10. Repeat the procedure for elevator channel: put out elevator tell-tale lights using elevator centering knob, flip elevator switch, check vertical speed and fine-tune with centering knob again. You can finally make yourself a coffee as the autopilot is flying the airplane.

## ***Bombardier Turns***

The Bombardier can disconnect the stabilizer gyro from the autopilot, and turn the plane manually or by connecting the bomb sight to the autopilot. The ability to make precise coordinated turns this way is crucial for successful bombing. That's why the autopilot has "Turn Compensation" knobs [8] to fine tune autopilot controls. To perform tuning, order the bombardier to move the PDI fully left or right [11], which should produce an 18 degree coordinated turn. Adjust with the turn compensation knobs if necessary. After that, cancel the command for the bombardier by clicking on the 'Hold PDI' text again. This will connect the stabilizer gyro to PDI again and autopilot should smoothly center the PDI on its own.



On a 2D panel there's also an option to order a specific heading hold. Just remember that you're not switching the autopilot to hold a heading. Instead you are ordering your bombardier to keep PDI in such position that the airplane will follow a specific heading.

### Pilot (Turn-control) Turns

A pilot can order a turn using the turn control knob [4]. It works differently than bombardier turns. When the knob is moved from the center position, it locks the PDI in place and disables the stabilizer gyro so the autopilot will not follow it in a turn. Instead you can order a specific bank by turning the knob left or right. Provided that you have tuned the autopilot for bombardier turns, you don't have to make further adjustments. In case of steep turns, loss of altitude or some skid/slip may occur. Don't correct that with turn compensation, as this will destroy tuning earlier performed for bombardier turns, and their precision has higher priority. Use centering knobs instead and re-center after exiting the turn.

### NOTE:

**You should move the turn control knob slowly**, because rudder and elevator deflection is proportional to knob position, not actual aircraft bank. Violent moves will produce over-steer. To exit a turn, first rotate the knob to '0' position either left or right, and only after the wings are level, rotate it back to 'center'. In '0' position the ordered bank is 0, but the PDI is still held in place. In 'center' position, the PDI is connected to the directional stabilizer gyro and it again corrects for course deviations. So returning the knob to 'center' position while still in a turn will cause the PDI to catch a new course too early resulting in a sudden turn in the opposite direction.

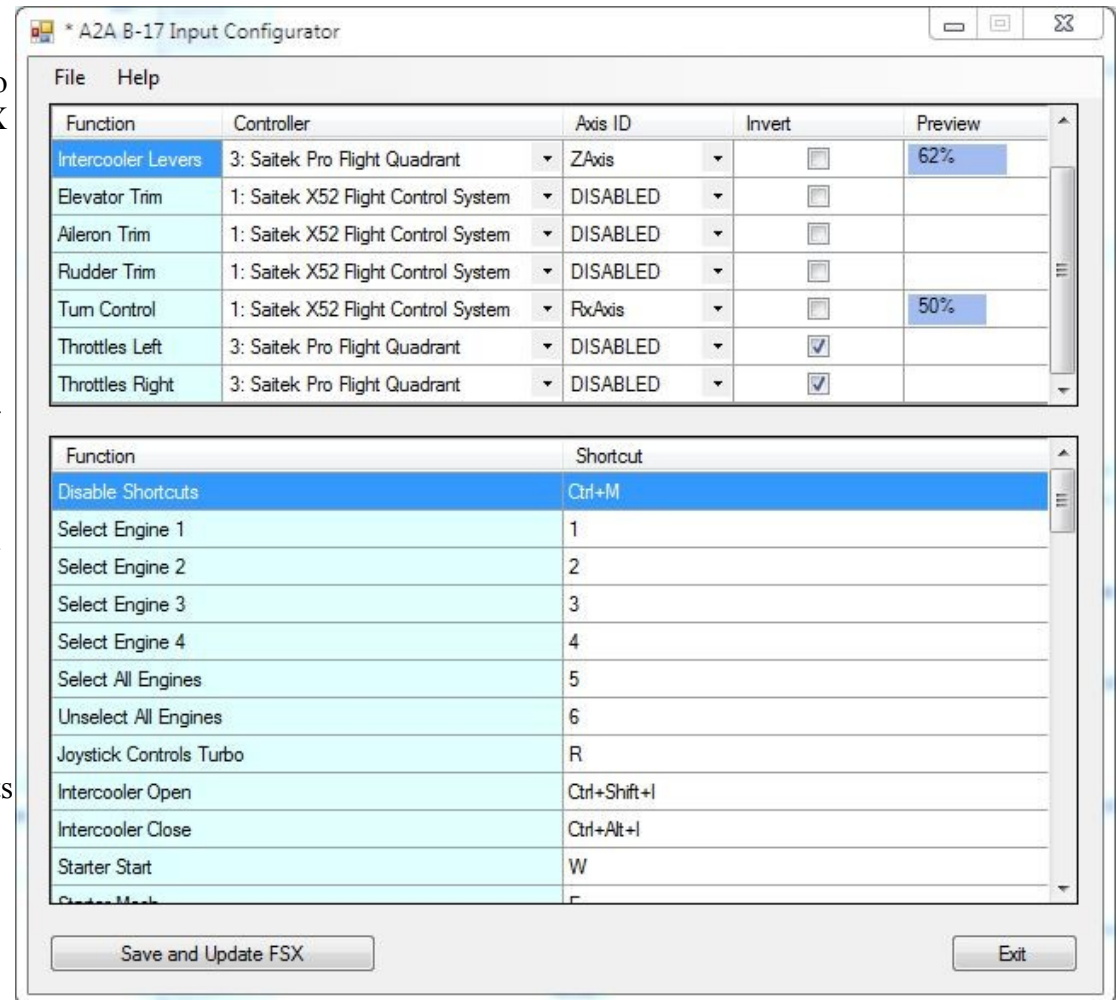
## Custom Key Mappings

The B-17 Input Configurator is a small utility that allows users to assign keyboard or joystick mappings to many custom B-17 functions that can't be found in FSX controls assignments menu. It can be found in the A2A/B17/Tools folder inside your FSX installation directory.

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

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

When done with the assignments, press "Save and update FSX" button. This will instantly update shortcuts for B-17. There is no need to restart FSX or even reset flight for the changes to take effect, you can adjust shortcuts on the fly.



**Shortcut tips:**

*Disable (custom) shortcuts* - All shortcuts and axes assignments made with this utility have higher priority than FSX ones, so they will mask identical shortcuts made inside FSX if they exist. Use this function to access them if you need.

*Engine selection* shortcuts can be used to quickly select one or more engines. They can be extremely useful. Some custom shortcuts like engine starters will work only when single engine is selected.

If you have split throttle then you may consider left and right engines to separate axes (*Throttles Left* and *Throttles Right*). In real B-17 differential throttles are often used to maneuver the aircraft on ground or in crosswind conditions.

*Joystick Controls Turbo* shortcut can be used to switch your joystick throttle axis between controlling aircraft throttles (default mode) and manifold pressure selector (turbo). To use this function properly, first press the shortcut (or use command on 2D panel), then move your joystick throttle so its position aligns with current throttle levers or MP selector position, whichever is selected at the moment. Before proper alignment, joystick throttle input will be discarded to avoid sudden change in engines power. During flight, pilot normally operates MP selector leaving throttles fully forward most of the time.

## Chapter 6: The Boeing B-17G

By Mitchell Glicksman

Among the heavy bombers of WWII, the B-17 wasn't the fastest, highest flying or capable of carrying the heaviest bomb load. It wasn't even the most numerous American heavy bomber; that prize goes to the Consolidated B-24 "Liberator". Yet, the B-17 is the most famous and most beloved of them all. Is this due merely to effective publicity, or to something more substantial? Perhaps it is the way she would bring her crew home after receiving extensive battle damage in combat which would have downed most other aircraft. Maybe it is her appearance, those powerful, classic lines which seem to define the word "bomber".

"Memphis Belle", "Aluminum Overcast", "Fuddy Duddy", "Shoo Shoo Baby", "Picadilly Lilly", "My Gal Sal", "Sentimental Journey", "Yankee Lady"--these are some of the names of famous B-17s which have been remembered so well, so fondly, for so long, and by so many. Robert Olds, Colin Kelly, Frank Kurtz, Curtiss LeMay, Robert Lee Scott, Paul Tibbets, Robert K. Morgan, Joseph Kennedy Jr., Nancy Love, Clark Gable, James Stewart. Gene Roddenberry, Norman Lear, Tom Landry--these are the names, some of which you may have heard of, who flew B-17s or were part of her crew.

She is a movie star, having appeared in many films: "Test Pilot" (1938), "I Wanted Wings" (1941), "Flying Fortress" (1942), "Desperate Journey" (1942), "Air Force" (1943), "Bombardier" (1943), "Memphis Belle" (1943), "The Target For Today" (1944), "Sunday Dinner for a Soldier" (1944), "Passage to Marseille" (1944), "Captain Eddie" (1945), "God is My Co-Pilot" (1945), "The Best Years of Our Lives" (1946), "Fighter Squadron" (1948), "Chain Lightning" (1948), "Command Decision" (1948), "Twelve O' Clock High" (1949), "When Willie Comes Marching Home" (1950), "The High and the Mighty" (1950), "Top of the World" (1955), "The Lady Takes A Flyer" (1958), "The War Lover" (1962), "Dr. Strangelove" (1964), "Thunderball" (1965), "La Grand Vadrouille" (1966), "1000 Plane Raid" (1969), "Tora Tora Tora" (1970), "The Biggest Bundle of Them All" (1968), "MacArthur" (1977), "1941" (1979), "Brady's Escape" (1983), and "Memphis Belle" (1989).

The B-17 has often graced our television screens as well: "Twelve O' Clock High" (1964-67), "Baa Baa Black Sheep" (1976-78), "We'll Meet Again" (1982), "Amazing Stories - The Mission" (1985), "The Tuskegee Airmen" (1985), and "Last Chance Detectives" (1994-96).

The image of the B-17 is familiar to millions. She appears and is portrayed in tens of thousands of paintings, drawings and photographs. Hundreds of books have been written and published in which the B-17 is a minor or major character. From model airplanes to computer games, the B-17 is a favorite.

Her military life began on January 17, 1936, commensurate with an order for 13 YB-17s, it was designated to be the 17<sup>th</sup> bomber-type aircraft to be accepted into potential regular line service by the United States Army Air Corps (USAAC) as it was known at that time (until it's name was changed to the United States Army Air Forces (U.S.A.A.F.) in June, 1941, making it a larger and more independent service, on its way to complete independence as the United States Air Force on September 18, 1947 under the National Security Act).

The voluminous history of the B-17, arguably the most famous bomber of all time, is well known by many, and is readily available for those who wish to inform themselves of it. We will not belabour you with it here. The B-17's pre-war, war time and post war service record is legend; and, all of the many statistics and facts about it, both the dry and the fascinating, may also be equally easily acquired. We will spare you this as well.

Yes, the B-17 is well-known, particularly so to those who love airplanes and aviation as we at A2A do, and as we know that you do, too. However, many of the most interesting truths about things that are "well-known" are often lost in the mist of time and myth.

For instance, regarding that name, "Flying Fortress", a seemingly wonderful epithet, redolent of poetic alliteration and of swift, confident, serene power; there are some people who may be surprised to learn that the name "Flying Fortress" was not coined by either Boeing or the Army. That very descriptive, but later ironically unfortunate name was given to what was then Boeing's Model 299 on July 28, 1935 on the first day that Boeing rolled it out and introduced it to the public -- long before it was evaluated and accepted by the Army.

As it happened, Richard Williams a newspaper reporter reporting in the Seattle Times about the new bomber that he had just seen was duly impressed with the unique sight of all of the many machine guns seemingly bristling from every portal. He promptly dubbed it to be a "Flying Fortress". Boeing liked the name and appreciated the publicity value of it so much that a trademark for the name was immediately applied for and received.

The airplane certainly seemed to be a veritable "fortress". No airplane prior to or contemporary with it had ever possessed such an impressive array of defensive weapons. The consequence of naming it is often that doing so imbues the named thing with certain expectations which are not always fair, well-founded or realistic. It was firmly believed for many years by the public, the Army and its crews (and among some it may still be so believed) that the so-named "Flying Fortress" was, in fact, in no serious danger from attack from the skies, and that it would be capable of absolutely and effectively defending itself against any fighter interception that might be thrown up against it. It was a "Flying Fortress", after all, and as such it was considered to be invulnerable in this regard. Accordingly, in 1943 no one in the U.S. Army Air Forces had any problem sending B-17s into combat on missions over hostile Europe without fighter escort all the way to and from the target.

History has proven over and over again, and always by the stern instruction of some great tragedy and loss of life that words like "invulnerable", "impregnable", "unsinkable", "indestructible", "undefeatable" and such have no place in the lexicon of any responsible and serious military strategist. The responsible and serious strategists of the U.S.A.A.F. were to be sadly reminded of this in 1943.

The British were the first to commit the B-17 in combat. 20 B-17Cs ("Fortress I" as they called it) were sent to bomb the naval barracks at Wilhelmshaven, an important naval base in Germany on the coast of the North Sea on July 8, 1941. The British strategists well-understood that the name "Fortress" was merely capricious publicity and that it was therefore not to be taken too seriously. The British were long used to capital ships being given such hyperbolic names as "Zealous", "Invincible", "Magnificent", "Illustrious", "Irresistible", and "Audacious". They well knew that these were just optimistically nice-sounding names, and were not actual, realistic descriptions of the ship's capabilities.

With this in mind, R.A.F. Bomber Command cautiously sent the Fortresses in at 30,000 feet, which was then considered to be an extremely

high-altitude to bomb from. Given their experience in the Battle of Britain, wherein the R.A.F. fighters had made short work of hundreds of attacking Nazi bombers which had come over in the daytime, the Brits were under no illusion of the Fortress's or any airplane's "invulnerability" against fighters. They wisely sent the "Flying Fortresses" in so high because at that time it was understood that at high altitude the Fortresses would be unlikely to incur much, if any fighter interception. As it turned out, they didn't. They went in high alright; in fact too high for them to hit anything that they were aiming at. The mission was deemed to be a failure, but thankfully not a tragedy as there were no losses, at least not yet.

After a series of similar daylight, high-altitude failures, R.A.F. Bomber Command, which since the 30's had been skeptical about daylight bombing mission anyway, discontinued and never returned to daylight bombing for the duration of the war. Ironically, the Nazis, whose began by bombing England in the daytime, quickly learned their lesson and they, too, discontinued daylight bombing operations over England in the fall of 1940, thereafter only sending bombers over the Channel at night.

The U.S.A.A.F., however, was not similarly dissuaded from daylight operations by either the British or German examples, or by the horrific losses which American crews incurred on such missions in 1942-43. Unlike the more skeptical and practical R.A.F., The U.S.A.A.F. was apparently quite impressed with the idea of having as an offensive asset what they believed to be a true "Flying Fortress". The U.S.A.A.F.'s concept of defense for the B-17s was the "close box formation". This defensive concept posited that when such a formation was properly formed the many guns on board the closely flying B-17s would be massed and positioned in such a way as to create a defensive screen which would effectively protect the bombers from incoming interceptors. This looked good on paper, and like most things that look good on paper, it had little validity unless and until it passed the test in the real world.

Apropos to this "paper plan", I once saw a diagram which had been distributed by the U.S.A.A.F. early in the war, showing the area of the sky that the B-17's guns could cover in an interceptor attack. It was a truly impressive drawing with hundreds of lines creating a veritable forest of defensive fire through which, it appeared, no incoming enemy fighter could possibly survive. The problem was that it was a totally deceptive drawing. The obvious fact is that none of the guns could fire down more than one of those lines at any moment. While a particular gun was aimed in one direction, an interceptor could be attacking unseen, or at least unfired upon from a different direction. As there were only eight main gun positions (Tail, right waist, left waist, ball, dorsal, left cheek and right cheek – there was no front turret as this drawing was of an "F" model), defensive fire could only be directed in eight possible directions at any given time, and certainly not along the hundreds of firing lines that the drawing showed.

Despite the well-reasoned dire warnings of the RAF about such missions, in 1943 the U.S.A.A.F. began to send hundreds of B-17s in close box formations on missions across enemy lines in the clear light of day and, to insure good bombing results, at fairly low altitudes. This was a perilous enough combination under any circumstance, made far more hazardous, if not nearly suicidal by the lack of any kind of fighter escort for the most dangerous part of the missions. Of course, it was at these low altitudes and in the daytime that the Nazi interceptors could do their terrible work most effectively.

The two American escort fighter types available at that time were either not available in sufficient numbers or not able to stay with the bombers all the way to and from their targets. The P-38F and G "Lightning" had the range to stay with the bombers. With its .20 millimeter



cannon and four .50 caliber machine guns it could do an effective job protecting the B-17s from Nazi interceptors. It was not, however, available for such operations in sufficient numbers as its two 1,425 horsepower, inline V-twelve cylinder, supercharged, Allison V-1710 liquid-cooled engines, particularly the superchargers and the propellers, were proving to be dangerously unreliable at high altitudes in the frigidly cold temperatures of the European winter skies. While the P-38 did excellent service in the Pacific theatre, where the missions were at lower altitudes and the air temperatures were far warmer, it was a disappointment in the early days of the European theatre.

With its 2,000 horsepower, twin radial, eighteen cylinder, super-turbocharged, Pratt and Whitney R-2800 air-cooled engine, and eight .50 caliber machine guns, the fast and powerfully armed P-47C and D “Thunderbolt” had no such operational problems as did the P-38, and it was available in sufficient numbers. It was more than a match for the Nazi interceptors when it met them; however, the P-47 did not yet have the range to stay with the bombers all the way to and from their targets, and had to turn back early in the mission. This was well-noticed by the Luftwaffe, who, immediately upon the disappearance of the fighter escort, sent up waves of powerfully armed interceptors to destroy as many of the B-17s as they could.

The resulting debacle and slaughter almost caused the cancellation of the entire U.S.A.A.F. daylight bombing campaign. Had such occurred, it would surely have enormously crippled the Allied war effort and perhaps extended the war for many years; however, a solution was on its way. However, a solution was on its way.

The P-51B “Mustang” was introduced to the conflict in August, 1943. It had six .50 caliber machine guns and was powered by the excellent 1,475 horsepower, inline V- twelve cylinder, super-turbocharged, Packard built Merlin 1650-3 liquid-cooled engine. Most importantly the P-51 was equipped with the newly-developed droppable fuel tanks which, along with its considerable internal fuel supply, gave that fine and reliable airplane enormous range. The P-51 was an effective escort fighter that could easily stay with bombers during the entire mission. With the introduction of this airplane, the largest part of the horrific B-17 losses which had been previously experienced was averted.

I wonder if the B-17’s sad history in the early days of the war might have been avoided if the name “Flying Fortress” had not been taken so seriously by some, or if had not been given that misleading, vain-glorious name in the first place.

Please bear in mind that what I have related above was no in any way the fault of the airplane itself. In fact, the B-17 was a good performing, sturdy and reliable airplane, gentle to handle, and able to take an extraordinary amount of battle damage and still return its crew safely home. With regard to these qualities it was superior to any of the other heavy bombers used in WWII.

Apparently, at the very outset of the war, there were some wise individuals at Boeing and in the U.S.A.A.F. who had not quite bought the hype and were not quite so certain that the B-17s in fact, whether massed in “close box formations” or not, would be quite so invulnerable to fighter interceptors as was being so boldly touted around U.S.A.A.F. strategic headquarters. They were not so certain that the B-17 as it was configured was indeed the “Flying Fortress” that it was cracked up to be. As the problem was that there were no fighter aircraft available yet which had the range to stay with the bombers all the way to and from the target, an ingenious solution was formulated - - modify a few of the bombers themselves to be the escort.

An attempt was therefore made to make the “Flying Fortress” live up to its name in reality. The YB-40 was the result. The second B-17F-1-

BO prototype which, notwithstanding its “BO” suffix was actually built by Lockheed –Vega, a subsidiary of the Lockheed Corporation, was taken from the assembly line in September 1942. It was re-configured into what was called “Project V-139”, which ultimately became the YB-40. While this project was originally to go to the Vega plant, it ended up at the Douglas plant as Vega had other and higher priorities for the production of other aircraft at that time. The YB-40 was a standard B-17F in every respect except that steel armour plate and a great many more defensive guns were added. The YB-40 was not intended to carry and drop bombs. The plan was that it would fly sprinkled in among the regular bomb carrying B-17s, and hopefully shoot down the interceptors.

Many additions and modifications were made to the B-17F to accomplish this goal -- the radio compartment was replaced with another twin .50 caliber machine gun turret position, located above and just forward of the ball turret. Each waist gun position had one more .50 caliber machine gun added resulting in a twin-gun arrangement. The mounts for these guns looked very like that for the tail guns. The B-17 was always most vulnerable from frontal attacks. To counter this, in the nose, the cheek guns mounted at either side just ahead of the navigator’s position, which had been removed at the factory from the original “F” model, and had been replaced when the airplane arrived at its bases in Great Britain, were now mounted in the YB-40. The bombsight and all of the other switches and controls that the bombardier would normally use were removed, as there would be no bombardier in this airplane. Instead, to bolster defense in the nose, a Bendix remotely- controlled chin turret with two .50 caliber machine guns was installed, operated by a gunner who sat in what was the former bombardier’s position.

The YB-40 mounted 16 - .50 caliber machine guns, almost twice the number of those carried by the standard B-17F with the cheek guns removed. All of these extra guns needed a lot more ammunition than did a B-17F. To house all the extra bullets, the bomb bay was converted into a munitions magazine, which was easily accessible in flight. Many of the crew positions were now protected by additional steel armour plate.

That pesky and inexorable natural physical law which provides that nothing may be gained in one place without a loss somewhere else, did not, of course, fail to operate with regard to this airplane. The addition of all those extra guns, extra ammunition and steel armour plate added over 4,000 pounds to the basic B-17F. The additional top turret and all those extra gun barrels sticking out into the air added a good deal of drag.

There was no commensurate increase of engine power to the YB-40. It had the same four, Wright R-1820-97, 1,200 horsepower engines as did the B-17F. Accordingly and quite predictably, the YB-40’s climb rate was reduced to about half of that of even a fully loaded B-17F, and its cruising speed was also reduced so much that it was much slower than the Fs. The speed differential between the standard B-17Fs and the YB-40 greatly increased after the Fs had dropped their bombs and were then much lighter. Since the YB-40s had no bombs to drop, it could only lighten its load (aside from the usual fuel and oil expenditure which it shared with the Fs) as ammunition was expended. The spectacle of the defensive escorts not able to keep up with the aircraft they were supposed to be protecting was sadly and ironically ludicrous, and wholly unacceptable.

Because of the deficiency in performance imposed by the additional weight of guns and ammunition without an increase in power, the YB-40 was doomed to be, and was, a failure. The YB-40 concept, which had looked so good on paper, similarly to the concept of the “close

formation defense”, failed the test in the real world. Without a way to increase the power of the YB-40 proportional to its increase in weight and drag, it had to be a failure. There was apparently no way to solve the escort problem without real fighter escorts.

The YB-40 project, while a tactical failure, led to two useful improvements in the next variant of the B-17, the “G”: The YB-40’s Bendix, remote controlled, twin .50 caliber machine gun “chin” turret which had proven to be particularly effective in combat, appeared in the B-17G. The disappearing and re-appearing “cheek” guns in the B-17F’s nose were retained from the YB-40 in the “G” model as well. However, the positions of these cheek guns were reversed from their positions as they had appeared in the “F” model. In the “G” there was now a gun in the left forward window and a gun in the right middle window, thus staggering the gun firing positions so that two men (the navigator and the bombardier) could simultaneously man and fire guns without getting in each other’s way in that fairly small and equipment-crowded space. This idea of staggering the cheek gun positions was carried over to the waist guns starting with the B-17G-50-VE, one of the later Vega batches. The Bendix chin turret and the new cheek gun positions had first been tested on the B-17F-115-BO 42-30631 and were slated to be installed as regular equipment beginning with the F-135. There were so many changes being introduced to the “F” model at that point that a new model letter was deemed to be warranted. B-17G-1 which resulted was the first batch of the most numerous and most heavily armed (13- .50 caliber machine guns) B-17 model to be produced.

In any event, once the P-51B came into use and American bombers could be escorted all the way to and from the target, mission losses to Nazi interceptors were reduced to an “acceptable level”, and the B-17 went on to take its considerable and venerable place in the great panoply of aviation history.

As four-engine bombers go, The B-17 was reported to be a delight to fly and very forgiving of less experienced or less talented hands. Landing speeds were under 100 M.P.H., and as slow as 80 M.P.H. when lightly loaded as it usually was when returning from a mission.

At the time the B-17 was first introduced, aircraft were deliberately designed to have gentle and slow landing characteristics. Virtually all of the first generation all-metal aircraft of every nation which were designed in the middle 1930’s share this trait in common. Of these aircraft, only the Curtiss P-40, which was judged and considered by many to be the most difficult U.S. fighter to land, had a landing speed which exceeded 90 M.P.H. There were many reasons, borne of the necessities of the times, why designers had engineered these characteristics into these airplanes:

Firstly, by the middle 1930’s there were still very few airports yet constructed in the United States which had long, paved runways. Dirt runways or grass fields were still the norm, even at military airfields. Accordingly, slow and gentle landing characteristics were deemed to be required for safe operations at these fields. In other countries things were even more primitive, and those few large airfields which existed were often not near enough to large cities. This is, by-the-way, why the trans-oceanic airliners of this period, such as the Sikorsky four-engine airliners, S-40 through the VS-44, continually improving and built from 1931 to 1937, and the Martin M-130 China Clipper built for Pan American in 1936, were all flying boats. There was almost always a harbour or a river near a big city with unlimited expanses of water to land and takeoff from.

Secondly, pilots were not yet used to or comfortable with aircraft whose landing speeds approached 100 M.P.H. In the 1930’s military Pilots

all over the world generally flew easy handling and slow landing airplanes. The biplanes and early monoplanes that had been in service up to that time landed at very slow airspeeds. The B-10, which preceded the B-17 in the USAAC was in service from 1933-35. It was the latest and most modern bomber of its time and it landed at only around 65 M.P.H., which was considered pretty “hot”.

Thirdly, up until breakthroughs in metallurgy and mechanical design which occurred in the middle 1930's, the available materials and technology used in the construction of landing gear components and the designs of that time were not yet sufficiently developed to safely enable aircraft to travel at fast speeds on the ground such as would occur in a landing at higher speeds. Aircraft components such as landing gear struts, tires and brakes were often unable to handle the loads and moments imposed by the fast landing and takeoff speeds of large aircraft, particularly at heavier loads. Retractable landing gear was till a novel design and in its infancy in the 30's. Landing gear failures because of structural overstress were common. This is why the Douglas DC series of transport aircraft and the B-17 itself, as well as other aircraft, were designed so that a considerable part of the main wheels were not fully enclosed, even when retracted. This was done so that in the event of a gear collapse when landing, or if the wheels failed to extend, there would still be some part of the wheels protruding to lessen the damage to the airplane. Such occurrences were common at that time.

It is well to remember that aircraft which were first developed in the middle 30's, as was the B-17 in 1935, came into existence at a time of great transition in military aviation. The biplane era was coming to a rapid close as monoplanes began to dominate the military skies. More powerful engines were being produced all the time, and there was a greater and growing understanding of advanced aerodynamics and how to design aircraft which could perform to levels unheard of only a few years or even months before. Accordingly, as these new aircraft were built and flown, new aviation speed, altitude and endurance records were being broken on a regular basis. It was truly the golden age of aviation.

In the 1930s, the development and improvement of every kind of airplane, civilian and military, was moving at a rapid pace. In the military, with regard to single engine fighter/attack types, in April 1932, the U.S. Army's first all-metal monoplane attack aircraft, the open cockpit, fixed landing gear Curtiss A-8 “Shrike” was introduced, beating into active service the similarly open cockpit, fixed landing gear Boeing P-26 “Peashooter”, the Army's first monoplane fighter, by eight months. The P-12E and Curtiss P-6E biplanes were beautiful and excellent in their time, but by the middle years of the 1930s they were antique and almost quaint. These airplanes were still on the active rolls of the Army Air Corps until 1941 and 1942 respectively although they had long since been retired as first –line fighters, and spent their last years reassigned to training duty. To its credit, the Army Air Corps seemed to gracefully accept the monoplane and the outstanding performance that it was capable of as soon as the first practical designs were available.

Always the more conservative service, the U.S. Navy was apparently more hesitant and reluctant to accept monoplanes than was the Army. The Navy held onto the wickedly maneuverable and classic but hopelessly outdated Grumman F-3-F biplane fighter until as late as 1938. It was not until that relatively late year that it was replaced as a first-line fighter by the Navy's first monoplane fighter, the all-metal Brewster F2A “Buffalo”. The Navy's second and much better monoplane fighter, the Grumman F-4-F “Wildcat” (which curiously and tellingly, started its life on the designer's table as a biplane, the XF-4F-1), entered naval air service no sooner than September 1940.

Interestingly, Army Air Corps' multi-engined, monoplane bombers were introduced well ahead of its monoplane attack/fighter aircraft. In

1930, fully two years ahead of the AAC's first operational monoplane attack aircraft and almost three years before the AAC's first monoplane fighter, the first all-metal monoplane bomber, the open cockpit twin engine Martin B-7, with its graceful gull-wing and retractable gear, entered service. The short-lived Boeing B-9, also having open cockpits, replaced the B-7 in 1932. The B-9 was quickly replaced in 1933 by the far more modern Martin B-10 which had an enclosed cockpit and crew compartment. No AAC fighter had an enclosed cockpit until December 1934, when the two-seat Consolidated P-30 entered service.

As a perfect example of the amazingly fast development in aviation in the 1930s, it was only two years between the entry of the Martin B-10 into the AAC and Boeing's introduction of the Boeing B-17, the most sophisticated and complex airplane in the world at that time. Incredibly, only three years had elapsed from the open cockpit B-9 to the fabulous B-17. The B-17 was something entirely new and unseen before (except for the experimental Boeing Model 294, the XB-15 which was never intended to be an operational aircraft and was a test-bed for many of the ideas and design concepts which led to the B-17). The B-17 was the B-2 Stealth Bomber of its day. The performance and complexity of the B-17 compared to what had come immediately before it was massively impressive. In fact, its size and complexity was also its undoing on its second evaluation flight on October 30, 1935.

Because of its sheer physical size, the use of exterior control surface gust locks was impractical. The B-17 was, therefore, the first aircraft to have in-cockpit control surface locks installed, which, of course, had to be unlocked before each flight. Because aircraft prior to the B-17 were so relatively primitive and simple, the ritual call and response of checklists before flight had not yet become a part of normal operations. On that second evaluation flight, the pilots, Army Air Corps test-pilot, Major Ployer Peter Hill, and Boeing company test pilot Les Tower, both of whom were highly experienced aviators, neglected to unlock the controls and apparently did not even perform a "controls free and operating properly" check. The precious and sole Model 229 prototype crashed on takeoff, killing both pilots and seriously injuring the other crewmen on board.

As this was the only Model 229 built at that time, and as it was the sole evaluation aircraft upon which Boeing had pinned its hopes for an Army contract, things looked pretty grim for Boeing and its fabulous, ambitious airplane. Now without an airplane to present for evaluation, Boeing did not get the contract for the YB-17 for which it had been developed and built at great company expense. Many of the Army Air Corps' evaluators were equally disappointed at this turn of events. However, not all of them were. Some of them had serious reservations about the YB-17.

This new behemoth of an airplane proposed by Boeing cost much more than any airplane ever before submitted for their consideration. There were some in the Air Corps who were understandably concerned about this, particularly as the country was still in the throes of the Great Depression. Accordingly, the Army temporarily cancelled their order for 65 B-17s and purchased, instead, the far less spectacular but well-proved twin-engine Douglas DB-1, designated the B-18 "Bolo", a derivative of the DC-2 transport airplane. This aircraft saw duty as a coastal patrol bomber during WW II; and, in its role as an excellent bombardier trainer, it may have been the first aircraft to have had the revolutionary Norden bombsight installed in it.

It is indicative of the simplicity of the times that the use of a checklist and a simple “controls free” check had not yet become a part of normal and required pre-flight operations. While the B-17 went on to its glorious future as one of the greatest bomber of all time, because it was so ahead of its time it almost sunk itself into oblivion.

## **Flying the B-17G**

So, what is the B-17 like to fly? Pilots report that the airplane is a very pleasant airplane, that it is “honest” and does what it is asked to do, within reason. At anything below maximum weight it is somewhat overpowered. At the very light weights that these aircraft typically landed at after a long mission, with all bombs gone and less than 1/3 fuel in the tanks, it was very maneuverable and positively responsive to power changes. At these light weights, a missed approach and go-around was easily accomplished and it is reported that little or no pitch trim change was required in this situation.

Normal operations did not tax the Pilot unreasonably. The elevators remained effective throughout the entire airspeed range of the airplane, even at the lowest airspeeds just before touchdown. Setting an airspeed in a climb or descent was no problem and the airplane responded gently and intuitively. Trim at cruise was similarly not an issue as the B-17 was very stable, but still pleasantly responsive for so large an airplane. Instrument flying was facilitated by its overall excellent handling characteristics. Due to the large fin and rudder, the yaw axis, in particular, was excellent and normal turns required little rudder input.

Takeoffs were usually made from the three-point position, particularly when heavily loaded, and required only that the aircraft be driven down the center of the runway. The B-17 would essentially takeoff by itself. Landings were not much more difficult, and either a three-point or wheel landing was easily accomplished.

In the air, the B-17 was at ease and was a graceful and gentle flyer. On the ground, however, it was entirely a different story. The B-17 was the last heavy bomber in U.S. service to have a tailwheel. Accordingly, the 17 was not graceful on the ground and required some careful and patient handling. When conditions permitted, the inboard engines were used to taxi the aircraft, turns being made primarily with the use of differential throttle in addition to rudder and/or brake input. Care had to be taken not to brake too hard after touchdown or to pivot on a wheel in a sharp turn as this could do and often did damage to the wheel and/or landing gear, and sometimes could even blow out a tire. Visibility from the cockpit was limited from both the Pilot’s and Co-Pilot’s positions, and the other crew-members were often enlisted to spot and report obstructions or traffic on the ground.

That large fin and rudder, which so facilitated turns and stability in the air was nothing but a headache on the ground. In any kind of cross-wind it would try to weathercock the airplane into the wind, making taxiing difficult in many instances. Pilots would regularly taxi with the tail wheel locked to aid taxiing stability. Even then, it is reported that it was always a fight keep the 17 on track on the ground in a wind from



either side.

Interestingly, and somewhat sadly and ironically, the very easygoing nature and gentleness of the flying qualities of the B-17 led many of its pilots to become somewhat slack and incautious when they later flew other, more demanding aircraft. Because of this, serious accidents sometimes occurred, some of them fatal.

As mentioned above, the B-17 came to life during a period of great transition and rapid change. It may be difficult for us today to truly understand what it must have been like for pilots in that era. It was only the short span of a few years between the fabric covered, open cockpit, fixed landing gear biplane fighters which could hardly fly much faster than 200 M.P.H., and the sleek, all metal, 2,000 horsepower, 400+ M.P.H., 40,000+ foot ceiling aircraft of WWII. The strain on pilots to keep up with all of this hurtling, burgeoning technology and performance must have been staggering. It also must have been exciting.

The B-17 is unique in that during its service life it flew in the same military skies with both antiquated biplanes, little more developed even by the middle 1930's than the pioneering fighter aircraft of WWI, and also with the first and second generation jet aircraft of the 1950s.

## **The B-17 as a Civil Airliner**

Of the civil B-17s, perhaps the most interesting and elegant civil conversion of the B-17 was done by Sweden during WWII. The way it happened was this:

During WWII Sweden was a neutral country. While continental Europe was under the terrible thrall of the Nazi regime, which relied upon neutral Sweden for what is now considered the controversial exportation of iron ore and other vital materials to Germany via Narvik, Norway. Despite this, the people and the government of Sweden were, in essence, quite sympathetic to the Allied cause, generally collaborating with the Allies whenever possible.

Accordingly, like Switzerland, Sweden was an ideal place to fly to for B-17 crews in crippled aircraft when they could not reach their home bases, rather than to be forced to ditch in the dangerously cold North Sea, or worse, to be forced to land in or bail out over enemy territory. Altogether, approximately 1,200 American Air Force crewmen who had landed their aircraft in Sweden were interned as that country's guests for the duration of the war, unless an exchange for German prisoners who were similarly in Allied hands could be arranged. Reports and accounts of the Swedish internment indicate that it was, as one might expect, comfortable, friendly and pleasant; not at all a "prisoner of war" type of situation.

Because of the constant threat to Sweden by Nazi Germany, who had brutally occupied both Denmark and Norway early in the war, Sweden could not release these interned Americans outright during hostilities. Even though Sweden was “neutral” during the war, the Nazis maintained a visible and ominous presence there, and kept a close, suspicious eye on things. Accordingly, Sweden was in a delicate and dangerous situation throughout the war, with a gun literally placed squarely to its head at all times. This, however, did not prevent the “mysterious” disappearance of hundreds of Americans from Sweden due to a series of covert aerial “courier” missions undertaken by the OSS (“Office of Strategic Services”, the predecessor to the CIA) under cover of darkness.

One of the most unusual prisoner exchanges permitted by the Nazis was for Sweden to release 300 American airmen to England in exchange for nine of the B-17s which had landed in Sweden. Apparently the Nazis were glad to see those nine B-17s permanently out of Allied hands and not returning to the skies over Germany. In any event, Sweden now had nine modern heavy bombers to do with as they wished -- as long as what they wished to do with them it was peaceful.

These nine American B-17s went to the Swedish government-owned international airline at that time, SILA (*Svensk Interkontinental Lufttrafik Aktiebolag {AB}*), who, in turn, gave them to ABA (*Aktiebolaget Aerotransport*) which merged with SILA after the war and became the Swedish part of the Scandinavian Airlines System (SAS). Prior to and during WWII, ABA was the Swedish partner of the “Scandinavian Air Express”, a purely domestic inter- Scandinavian/European airline, operated jointly with KLM (*Koninklijke Luchtvaart Maatschappij* -- Royal Dutch Airlines) and Aero O/Y (which later became Finnair).

Of these nine B-17s, three “Fs” and four “Gs” were converted into beautiful 14 seat airliners by SAAB (*Svenska Aeroplan Aktiebolag* -- Swedish Aeroplane Limited), the Swedish government-owned aircraft company, and were flown on regularly scheduled domestic flights in and around Scandinavia and Europe until 1946, when the un-pressurized B-17s were replaced by faster, tricycle gear, pressurized, and much more efficient and suitable Douglas DC-4s.

## **The Lady's Crew**

Being a crew-member of a B-17 or any heavy bomber in the WWII era was a communal, collective experience. Each crew-member had his own particular set of duties and responsibilities, but these were not limited to his own position. Each crew-member was expected to know something about the other positions in the airplane and to help another crew-member at any time that such help might be needed. A good airplane Captain, the Pilot in virtually all instances, was expected to train and encourage his crew to cooperate and to work together as a close-knit team.

There are many recorded instances where one of the crew actually landed a badly battered B-17 when the Pilot and Co-Pilot were both incapacitated or killed. Usually this crew-member was someone who had taken some pilot training and had either washed out or switched to another position during training. It was not uncommon for a Radioman to man a waist gun or for a Navigator or Flight Engineer to toggle the bombs when it was necessary. The Pilot and Co-Pilot were both expected to know the details of every position in the airplane, and to be able to man that position or aid any member of the crew if required.

The B-17 typically had a ten man crew: Pilot (aircraft Captain), Co-Pilot, Flight Engineer/top turret gunner, Navigator/ cheek gunner, Bombardier/front turret gunner in the “G” model, Radioman/ dorsal gunner, Left and Right Waist Gunners, Ball turret gunner, Tail Gunner.

The Radioman, Waist, Ball and Tail gunners were enlisted crewmen, often corporals or sergeants; the other crew-members were officers. Occasionally, the Flight Engineer would be a Top Sergeant (six-striper) but he was sometimes a First or Second Lieutenant.

### **The Pilot**

The pilot was the aircraft “Captain”, regardless of his actual rank. He was like the Captain of a ship at sea, and his word was law on board the airplane. In addition to his the primary job of flying the airplane, the Pilot also oversaw the proper use and operation of the entire aircraft and of its engines and systems. He was in command at all times. He would delegate the flying of the airplane to the Co-Pilot from time to time and partially to the bombardier when commencing the bombing run. The Pilot had to know every thing about the airplane and the details of how everything worked on board. He was trained to be able to man any of the positions in the airplane if necessary, with the possible exception of the operation of the Norden bombsight, a highly technical and closely guarded secret which was solely the province of the bombardier (this was the official word on that matter; however, in practice, there are many recorded instances of Navigators, Co-Pilots or other crew-members who took over the bombardier’s position and dropped the bombs when the bombardier was either killed or otherwise incapacitated before reaching the bombing run).

The Pilot helped to train his crew to do their jobs as he wanted them to be done and in accordance with operational orders from his superiors. It was the Pilot’s duty to see that the crew worked co-operatively, efficiently and had good morale. He was the crew’s “papa”, father confessor, mentor, taskmaster, disciplinarian (when necessary), and also one whom everyone on board looked up to and trusted to get them home with a whole skin and in one piece, or at least with all of the pieces that they took off with. It was a big job which required an intelligent, mature, well-trained, skilled, dedicated and seasoned individual with great aeronautical knowledge and who also possessed good leadership, organization and command skills.

### **The Co-Pilot**

The Co-Pilot is the Pilot’s closest teammate, and the one which he depends upon to help him in the orderly and proper operation of the aircraft. He is the Pilot’s backup man, and like the Pilot, he is trained in the operation of the aircraft, the engines, and all of the systems. He, too, is trained to man any position in the aircraft. Some of the controls necessary to operate the engines and systems on board are on his side of the cockpit and he is trained to operate these controls to keep everything running as it should. As the Pilot in this simulation, you can elect to operate everything yourself, or to delegate the starting of the engines, the operation of the propellers (rpm), the oil coolers and/or the cowl flaps to your Co-Pilot as you wish. The Co-Pilot will remind you, when and if it becomes necessary, to do various things that you may have forgotten to do. The duties which may be delegated to the Co-Pilot in this simulation are historically and technically correct and have been included in order to add realism and a greater sense of immersion.

### **The Flight Engineer**

The airplane is his baby. Along with the crew chief on the ground, he considers it to be his property, which he is generously permitting you and the rest of the crew to borrow for a while. He is also the top-turret gunner. His usual station is between and just behind you and the Co-Pilot. He may or may not be an officer, but he will not hesitate to “advise” you, the Captain, regarding the proper way to handle and operate “his” airplane. The Flight Engineer is trained, among many other things, to operate the manual landing gear and flap cranks as well as the fuel transfer system. Along with the Pilot and Co-Pilot, he is an authority on how the airplane should be operated. He has had special training in the technical details of the aircraft engines and systems, even beyond that of the Pilot and Co-Pilot. They will often defer to him and rely on him to keep everything running correctly. The Flight Engineer is a highly respected member of the crew and, after the Pilot and Co-Pilot, he is in charge of the overall operation of the airplane. He is constantly moving around in the airplane when he isn’t in the cockpit or manning the top turret, checking to see that all is running properly and that no one has any problems with their gear. He is the liaison between the rest of the crew and the Pilot. If anything goes wrong or needs to be done, he will be the one reporting it to the Pilot as he will occasionally do in this simulation.

### **The Navigator**

His job is self-evident. While his job was historically one of the most crucial, in this simulation he has no duties. All of the navigation is up to the Pilot (you).

### **The Bombardier**

The entire purpose and reason d’être for the B-17, or any bomber, is so deliver the bomb load on the target. The responsibility for this is the Bombardier’s. In the B-17G the Bombardier did more than to drop the bombs on the target. He manned the front turret as well as helping to setup the C-1 automatic pilot and operating it along with the Pilot, as he does in this simulation. Upon command from the Captain, he can open and close the bomb bay doors and drop the bombs, or the Pilot can do this himself. This too is featured in this simulation and it is technically and historically accurately depicted.

### **The Radioman**

In the mid 1930’s when the B-17 was designed, radio was still a relatively new thing, the very first public radio broadcasts having begun in 1920. It was considered that the use of the radio was a complicated a matter and should not be added to the Pilots’ duties. Accordingly, an entirely separate and fairly large crew station (the radios of those days were truly huge and very heavy) was designed into the B-17. The Pilot and Co-Pilot had backup radio controls in the ceiling of the cockpit, but it was the Radioman who had the primary duty of operating them. The Radioman also manned the single .50 caliber dorsal machine gun. As mentioned elsewhere in this manual, your Radioman will, from time to time, pick up a broadcast from a commercial radio station and let you know that you can hear it on your Liaison channel. If you switch to that channel, you may hear a popular song, a sports report or a political speech, all of which were recorded from actual radio broadcasts of the 1940s. As you fly into range you will at first hear static which will become a clearer signal as you fly into range. Then, as you fly out of range, the signal will once again fade into static. This will add a fascinating,

incredibly realistic and immersive feel to your flight, and it is another exclusive and completely original feature of the A2A Accu-Sim B-17G.

### **The Waist Gunners**

Besides manning the waist guns, they also operated that APU (Auxiliary Power Unit) which was located in the rear of the center section of the airplane. The APU provided electrical power to operate the engine starters and other electrical systems until the engine driven generators could take over. As the Pilot, you may command one of the Waist Gunners to start and to stop the APU. He will acknowledge your command and will report back to you when it is up and running.

### **The Ball Turret Gunner**

Always, for obvious reasons, the smallest man in the crew, he manned the Ball Turret when the airplane was over enemy territory. While this may seem to have been a particularly dangerous position, historically it was actually the safest place to be during an enemy interceptor attack. Interceptors would usually concentrate on the cockpit, the nose, the tail, the engines and the fuel tanks in the wings. The Ball Turret, being outside the actual body of the airplane, was not as susceptible or as vulnerable to as much enemy fire as were the other positions.

### **The Tail Gunner**

Manning the remotest and loneliest position in the airplane, the Tail Gunner was usually the busiest crewman during an interceptor attack. There were always some interceptors attacking from the rear, and it was his job to shoot them down if he could. It was this most rearward position which took much of the heat during an attack. The Tail Gunner entered the airplane through the large side door on the right side of the airplane just behind the wing. He then crawled back, over the tailwheel retraction mechanism to the rear of the fuselage to his position. However, he had his own emergency escape hatch just behind him on the right side of the airplane (to his left as he faced backwards) if he needed to get out of the airplane in a hurry. This hatch was also used to pass his parachute and gear to him (see “Flight Gear and Apparel” below), to arm his guns and to service his oxygen tank and equipment. The Tail Gunner’s escape hatch is modeled in this simulation and it opens and closes when the main doors are operated.

## **Dressed To Kill** (and stay alive)

The crews of the B-17 and of all the U.S.A.A.F. heavy bombers had very specific and specialized flight apparel and gear. This apparel and gear was designed to help them fight more efficiently and comfortably, and to keep them alive in the very harsh conditions in which they found themselves in combat in a B-17 at high altitude. There is a dizzying variety of jackets, helmets, trousers, gloves, boots and all manner of flight gear that was used by American bomber crews during World War II. What follows is not, repeat not intended to be an exhaustive study of such, which would require a fairly thick book to do justice to the subject. This is merely a cursory overview of sorts of what American bomber crews wore and the gear that they used.

The B-17 was not a pressurized airplane. It was also not completely sealed from the ambient air, the temperatures of which even in the summer were well below zero degrees Fahrenheit at the high altitudes at which these missions were flown. Up until the “G” model, the B-17’s waist windows were opened when the guns were used and whatever the temperature was outside, that was what it was inside as well. Since missions could last for as long as ten hours or sometimes even more, depending upon the distance to the target, the route to be flown, etc., crew comfort was not merely a luxury, but a necessity if they were expected to properly and efficiently perform their duties in combat.

With the advent of the B-17G, the guns in the waist were mounted in closed windows and a heating system was provided for the crew stationed to the rear of the cockpit. The cockpit itself always had a very efficient (sometimes too efficient) heater; but the nose position, receiving the undisturbed onrushing ambient air full in its face, was the coldest place in the airplane. The Navigator and the Bombardier in particular required fully heated suits to keep warm. Even with these, they would come up to the cockpit whenever they could to warm themselves.

Missions in warmer areas and/or at lower altitudes, such as were typical in the Pacific theatre required less bulky and less temperature-sensitive apparel and gear. Naturally, lighter and less specialized clothing was worn by flight crews during missions where the temperature in the airplane was not expected to be very cold. Sometimes just a simple coverall, parachute harness and Mae West over the usual AAF uniform were sufficient for these missions.

For missions in cold temperatures, however, flight apparel and gear had to be specifically designed to keep the crew warm --not an easy thing to do in what was essentially an airplane open to the elements. As the war progressed and lessons were learned, this apparel and gear was steadily improved and continued to evolve. Accordingly, what was used and available became quite varied as the war progressed. Here are some typical examples of such apparel and gear which bomber crews wore and used for the colder missions:

Flight crews who were going on high altitude (cold) missions always wore long underwear and regulation wool socks as foundation garments. It was understood that it was necessary to wear multiple layers of clothing to keep warm, and this was the first layer. Regulation G-1 trousers and a G-1 shirt were worn next. Almost everyone wore a thin A-4, HBT or later an AN-6550 flight suit next. These were khaki-green fabric coveralls which protected the basic uniform from stains and dirt and added another layer of insulation. Over that, before electrically heated clothing was the norm, enlisted crewmen wore heavy, Alpaca lined, leather Type A-3 or A-9 trousers and a heavy Alpaca lined Type B-10 jacket. Early in the war, crewmen’s hands were protected by unheated Rayon or silk gloves, leather R.A.F. gloves, or Type



A-9 Mittens. A silk scarf was often worn to protect the crewman's neck from abrasion and as an extra protection against the cold.

After a short while, flight crews going on cold missions typically began to wear the regulation F-1 "Blue Bunny", a shockingly blue-coloured completely heated fabric overall with heated leather gloves and booties. It was popular with crews early in the war for its heating efficiency, if not for its strange appearance.

This blue apparition evolved into the four-piece F-2, F-3 and F-3a Heated Suit which was worn under leather or fabric jackets. This electrically heated suit included Type F-2/F-3 trousers and liner, and a Heated Type F-2/F-3 jacket and liner, Heated Type D-1 or F-2 /F-3 shoe inserts covered by Type F-2 Outer Felt or Type A-6 or later A-6A leather boots and Heated Type F-2/F-3 gloves. All heated suits were plugged into an electric outlet located at all of the various crew positions and which were located throughout the airplane. The colours of the "F" series heated suits varied from brown to khaki-green to light tan.

For headgear a crewman might wear a leather B-2 cap, but more often he would wear a basic B-6, A-11 or R.A.F. Type C leather helmet which had provisions at each ear for a headset to be worn underneath. These were used interchangeably by flight crews and pilots of all types of aircraft throughout the U.S.A.A.F. during the war. Flying officers typically wore the "crusher cap" with insignia and a hard brim, but sometimes they also wore B-6, A-11 or R.A.F. Type C leather helmets. All crewmen had a pair of B-7, B-8, AN-6530, or R.A. F. Mark VII and Mark VIII goggles; all of which could be outfitted with interchangeable, various-coloured glass lenses as the individual wished.

The Pilot, Co-Pilot, Navigator, Bombardier and sometimes the Flight Engineer often wore leather jackets, either over regulation trousers or an A-4, or AN-6550 coverall. These jackets came down to the waist to allow sitting in comfort. The two most popular leather flying jackets worn by officers in the U.S.A.A.F. during the war were the A-2, B-3. The A-2 was light and unlined and was used primarily in the Pacific theatre of operations. The B-3 was heavier leather with a thick alpaca lining. Other cloth jackets used by U.S.A.A.F. crew were the "Tanker", B-9, B-10, B-11, and late in the war (December 1944) B-15 jackets. As the cockpit was the warmest area in the B-17 and quite comfortable even at the highest altitudes, the Pilot and Co-Pilot did not always wear a heated flight suit as did the rest of the crew; however, there were exceptions and it was a matter of individual personal taste.

Next, worn over the flight suit and under the parachute harness was the ubiquitous yellow, inflatable B-3 or AN-6519-1 life preserver, called the "Mae West" after the popular, well-endowed actress by everyone then and since.

Over all of the main clothing, early in the war, every crewman including the officers wore a Q.A.C. parachute harness which was usually white-coloured canvas. Later in the war, crews wore a Type A-3 harness which was similar to the earlier Q.A.C. but had more provisions for useful items to be attached to it. In the 8<sup>th</sup> Air Force from 1943 on, crews had the option of wearing an R.A.F. "Observer harness" which was popular and well-proven in combat.

All of these heavy-duty canvas parachute harnesses went around the legs and body to provide a completely secure attachment and foundation from which the crewman would hang from his parachute in the event of a bailout. In the 8th Air Force, beginning sometime during the first half of 1944, harnesses were colour coded as were corresponding parachute packs. This was made necessary because of the many different

types of parachutes which were in use at that time, each of which had different kinds of attachment hardware. The different coloured harnesses and parachute packs were so marked to prevent a crewman from mistakenly taking along the wrong type of parachute for his harness and then, for instance, trying to attach a red type parachute to a yellow type harness, etc. While, as mentioned before, most harnesses were white, some harnesses were made of olive drab canvas webbing with the appropriate colour patches applied.

All harnesses had a central quick release device which was located on the chest. It was also called a “bang box”. To quickly remove the entire harness after a bailout into the water, or if after landing on land the parachute had not deflated and was catching the wind, a crewman would twist the large knob on the release to unlock it and punch it hard inward towards his chest. The two leg and the two shoulder straps would then be released and the harness, along with the attached parachute, would fall away.

Interestingly, crewmen often tied their brown, hard leather service shoes to their parachute harness. This was done because their F-2 felt or A-6 leather flight boots were not considered to be practical for the kind of long hikes that might be required if an escape from enemy territory was to be attempted after bailing out.

An A-8b oxygen mask with its characteristic large leather air bladder, and later an A-14 mask with a flexible segmented air hose and no bladder, was attached to the harness as well to be used at altitudes above 12,000’, or whenever the Captain ordered “masks on”. This piece of gear was absolutely necessary to sustain life where the air is too thin to breathe. However, that fact did not prevent the good soldiers in the airplane from complaining about how hot, sticky and generally uncomfortable the oxygen masks were to wear. These masks contained a throat microphone, although a separate throat microphone could be worn for communicating when the mask was not worn.

After entering the airplane, the members of the crew would then attach their parachute to their harness. This was standing order in every aircraft and no Captain would take off until each crew man had reported in that they had successfully attached their parachute and that all was well with it. Flight Engineers would usually go throughout the airplane inspecting the crew to make sure that all was properly done with regard to the parachute. Of all the gear that the crew had, this item along with the oxygen mask was most crucial. Everyone understood that it could and would literally save your life and it often did for the thousands who successfully bailed out of fatally crippled bombers.

There were many types of parachutes used throughout the war by American crews. Some of the types used were the A-3, AN6513, AN6513-1a, AN6514, AN6514-1, R.A.F. “Observer” Type, B-7 backpack Type, with its typical waistband, and the B-8.

As the war progressed, combat casualties among the aircrews mounted to alarming numbers. An attempt to reduce the number of wounds caused by anti-aircraft (A.A.) shrapnel shards, bullets and exploding cannon shells was made by issuing body armour and hard helmets. It was a widely popular but unofficial practice for crewmen to carry a standard issue G.I. Army steel helmet which they attached to their harness for use in combat areas. These steel helmets were all one size, and a fiber helmet liner was inserted to individual head sizes. Air crews who were fortunate enough to have one of these helmets wore it without the liner so that it would fit over their leather helmets which had protruding radio headset ear pieces. Some crewmen would sit on their steel helmets during flack attacks to protect themselves from shrapnel coming up through the airplane’s floor from below.

The heavy (25 lbs., 10 oz.) M-1 armored vest with M-4 armored apron was issued to protect the body from shrapnel shards and bullets.

Nothing made in those days could actually stop a bullet that hit directly, but a glancing blow or a ricocheting bullet might be stopped. Nothing at all would protect a crewman from an incoming 20mm cannon shell, however. It was not perfect, but it was better than nothing at all, and it did save lives. The armour was made of 2 inch squares of manganese plates in a cloth binding. It had a red strap arrangement which when pulled, disconnected it so that if the crewman had to bail out he could remove it quickly. For head protection, an M-3 flack helmet was issued later in the war; but many crewmen continued to use the G.I. issue steel helmet mentioned above, even though the M-3 provided better side and rear head protection.

As if all of the above were not enough bulky clothing and gear to wear, many additional items were often attached and carried into combat by aircrews. Many of the harnesses had two “D” rings for attaching a C-2 Type inflatable one-man life raft/dingy. First aid kits were almost always carried as well, attached to a clip on the parachute harness.

Sometimes the bomber crewman had secured an H-1 and later an H-2 bailout oxygen bottle to his outer pants. The main difference between these was that on the H-1 there was a valve which had to be turned to open it, while on the later H-2, there was a green wooden ball, called the “green apple”, which when pulled opened the valve. This was necessary gear for bailing out from very high altitudes when it was contemplated that it might take a long time before he descended in his parachute to an altitude where the air was breathable (below 12000’). This oxygen bottle often had a tan cloth pouch which held the bottle and was strapped to the pants leg. I am informed that this was more often used by fighter pilots than by bomber crewmen, but it was available to and used by both.

Packets of “K” rations (a non-perishable portion of dry foods such as biscuits, dry sausages, chocolate and such named for its inventor, Dr. Ancel Keys) were usually carried in the flight jacket’s pockets as well as candy bars, cigarettes, a lighter (usually a classic “Zippo”) or matches, and other such items that might come in handy after bailing out over enemy territory. It was a strict order that items of personal identification were not to be carried on missions over enemy territory, so wallets, rings, bracelets and such were left at the base. An Army Air Force A-11 Type wristwatch with an olive drab or black cotton watch band was issued to everyone in the U.S.A.A.F. and was carried on every mission. These excellent watches were made by Bulova, Elgin and Waltham both for the U.S. Army Air Force and for the R.A.F.

A single-blade sheathed knife was often worn outside of the flight clothing to cut away tangled parachute lines after a bailout, for other utility purposes, or for use as a weapon on the ground if necessary. An optional but popular item which many crewmen carried with them on all missions over enemy territory was a loaded Army Issue Colt 45 caliber automatic pistol in a leather holster and extra clips.

## **A Faithful and Long-Service Queen**

I know that I promised that we would not be going into the long and storied history of the B-17 here. However, I think that it is appropriate and fitting to briefly and respectfully mention the following as bookends to the story of this great airplane: The B-17 began its military life on March 1, 1937, when the first of the 13 Y1B-17s which were ordered by the U. S. A. A. C. for testing were delivered to the 2nd Bombardment Group, based at Langley Field, Virginia. It ended its illustrious career in United States military services twenty-two years and eight months later, in October 1959, when the last B-17 variant, a PB-1G operated by the Coast Guard as an air-sea rescue aircraft, was retired from service.

More than twenty-two years of faithful and valuable service to the United States-- few airplanes can or will ever match that; and none, I think, with the panache, style and yes...the grace and majesty of the B-17. Fifteen nations' military services operated the B-17 and 14 nations operated it in civil service. The last B-17 which was used in regular military service was retired by the Brazilian Air Force in 1968.

## Now It's Your Turn

12,731 B-17s of all variants were built between 1936 and 1945 by Boeing, Lockheed-Vega and Douglas (B.V. D.). Of these, it is reported that only 58 airframes remain in existence with only 12 actively flying. Today, it is a rare treat indeed to witness the flight of a B-17, and even a rarer treat to have the opportunity to fly in one. Now, through the magic of the latest and most innovative home simulator technology available, this exquisitely detailed and accurate simulation will give you the opportunity you to feel what flying and operating a B-17 was like.



We hope that when you are flying the A2A Accu-Sim B-17 simulation you will experience not only the deep satisfaction that comes when you have mastered the workings of this complex and sophisticated airplane; but also, a sense of her magnificent history and of her gallant crews. We hope through this simulation that your appreciation will increase, at least in some small measure, for what our fathers and grandfathers sacrificed to preserve our liberty and freedom.

The care, thought and dedication that has gone into this project is beyond my powers to adequately describe. Let it suffice, then, to say that Scott, Rob, Lewis and all of us on the A2A team are proud to bring to you this faithful and meticulously detailed simulation of the B-17G, truly the “Queen of the Skies”. Enjoy.

## CREDITS

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