# Denarq "Twin Beech"

## Guide

A mod to enhance the

Local Legend V: Beechcraft Model 18

Microsoft Flight Simulator

# Denarq "Twin Beech"

## Guide v2.0

by Alexandre Baptista

## Preface

-For simulation only.

-Design to aid in operating Denarq "Twin Beech" mod with Local Legend V: Beechcraft model 18 for Microsoft Flight Simulator.

-This isn't a complete manual but only guide to systems added with Denarq mod.

-This mod is a work in progress and additional content will be added in the future.

## Instalation and extras

-To install the mod copy "Z_Denarq-enhancement-Beech-D18S" folder to your community folder.

-If it is your first install with v2.0, it is advised to delete state.cfg file before install.

state.CFG location:

```
STEAM: C:\Users\<USERNAME>\AppData\Roaming\Microsoft Flight
Simulator\SimObjects\<AIRCRAFT_NAME>\state.cfg

MS STORE:
C:\Users\<USERNAME>\AppData\Local\Packages\Microsoft.FlightSimulator_8wekyb3
d8bbwe\LocalCache\SimObjects\<AIRCRAFT_NAME>\state.cfg
```

-If you don't want the new sounds, simple delete the "sound" folder inside \Z_Denarq-enhancement-Beech-D18S\SimObjects\Airplanes\MSCarenado_D18S\Sound\ and copy the file "layout.json" that is inside "extras\default sounds" folder to your mod root folder.

-Inside "Extras" folder, there are two folders with default and free castering tail wheel with a FLIGHT_MODEL.CFG file each. Copy the file with type of tail wheel you desire to \Z_Denarq-enhancement-Beech-D18S\SimObjects\Airplanes\MSCarenado_D18S\.

## Quick overview

Given the main purpose of this mode to provide a much more realistic experience in operating the Beech 18, there are some features whose knowledge is essential in order to be able to use it.
- Complete overhaul of miniflo-L instrument with expanded functions to interact with Denarq mod (pag. 30).
- Persistent parameters like engine wear, batteries charge, fuel and oil quantities and fuel selector, crossfeed valve position and more.
-Custom made component failures.
- Scratch made oil system with oil (pag. 15).
- Custom made tools to manage Denarq "Twin Beech" mod:
    - refill oil tanks (pag. 16).

- Realistic procedures (pag. 38).
- Advance engine parameters with wear and damage (pag. 27).
Although, reading this manual is advised, understanding these previous points is mandatory to fly this plane.

## Index

## Aircraft identity

Planes of the same model are generally manufactured to meet certain specifications and standards, so they should behave very similarly. However, there can be some variation due to factors like manufacturing tolerances, materials, and individual components that can contribute to little differences in behavior. So, while they're designed to be consistent, you might still find some subtle variations between planes of the same model making each plane to have its own identity.

With  Denarq mod, each aircraft has its own uniqueness.

This "Aircraft identity" will focus mainly on engine performance and fuel quantity indicator error.

**Engine identity**

In reality, there are no two identical engines, especially when we talk about these older engines. Each engine has its own personality with slight variations in power, temperatures, etc.

Now, every time we perform a "reset" on the engine, a random value is generated that will influence many engine parameters, including power, temperatures, oil consumption, etc. This value will stay with the engine throughout its life until a new engine reset is performed and it will stay constant. The introduced variation can range from 0% to a maximum of 2%, so although the differences between engines will be marginal each one will behave slightly different from each other.

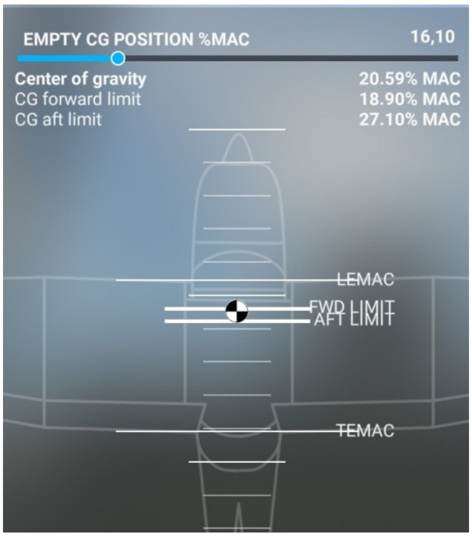
All the remaining variables that already existed will continue to coexist with this new engine variation concept.

## Weight and balance

In this mod, the weight distribution has been completely reworked to match the values of the real airplane. One of the baggage was moved forward, to the nose, and the positions of the fuel tanks, passengers and pilots are correctly placed off-center from the center line of the plane (see notes).
Before starting a flight is advised to watch "weight and balance" menu and confirm that center of gravity is within limits.

-Always fill left and right tanks to same fuel quantity.

-Avoid heavy weights on baggage stations. Given that they are very far from the center of lift, they contribute significantly to the weight balance of the aircraft.

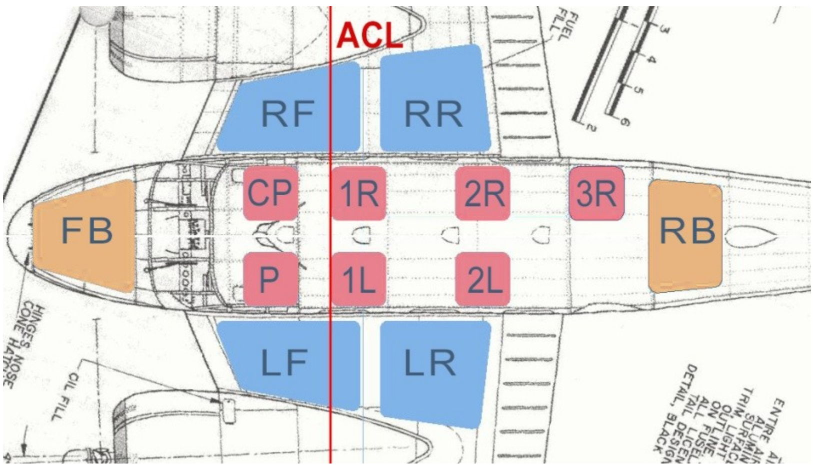



**Warning:**
**-Never change "EMPTY CG POSITION %MAC" slider inside "weight and balance# menu.**

ACL - Aero center lift

Fuel tanks:
LF - left Front Wing, 78 gallons
RF - Right Front Wing, 78 gallons
LR - Left Rear Wing, 25 gallons (Left rear)
RR - Right Rear Wing, 25 gallons (Right rear)

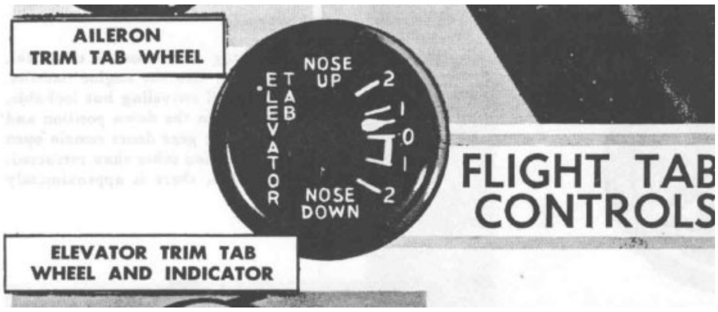
Stations:
FB - Front Baggage
P - Pilot
CP - Copilot
1L - Row 1 Left
1R - Row 1 Right
2L - Row 2 Left
2R - Row 2 Right
3R - Row 3 Right
RB - Rear Baggage




Notes:
-Due to off-center position of seats or unbalance tanks loads, it is possible that inside "weight and balance" menu in Msfs2020, there is a warning about off-center weight (red vertical line). Unless you have a difference over hundreds of pounds, this off-center warning can be ignored.

## Elevator trim

As in real aircrafts that came out of factory, there is a new white bar in Elevator tab gauge representing takeoff position.




*Picture from Beech 18 Flight Handbook*

Elevator trim for takeoff should be set according to center of gravity with your current payload. (watch "Center of gravity" line inside "weight and balance" menu.)

This would give a very neutral takeoff attitude.

Front weight payload (18.9%-21%)
Trim nose up a notch


Neutral weight payload (21%)
Trim neutral


Rear weight payload (near 27.1%)
Trim nose down


## Propeller feather

To feather the propeller, Beech 18 has two red buttons, located above main instruments panel, one for each propeller.


Engine oil is used for the feathering and unfeathering functions of the propeller. In these instances, both the pressure and quantity of the oil delivered to the propeller are increased by an electrical feathering pump.
Each motor requires 80 amps to function, so is the most electrical demanding single system in beech 18.

**Feather and unfeather procedure**

**PROPELLER FEATHERING BUTTONS.**
Two propeller feathering buttons, one for each propeller, are located on the cowl above the instrument panel (figure 1-10), in front of the pilot. These buttons operate the feathering pump motor and are so designed that to feather the propeller it is necessary only to "push" the button. The button remains in until feathering is complete and then automatically "pops out". To unfeather, the same button is again depressed, but in this case it is necessary to hold the button in until the engine is turning approximately 1000 rpm.

*Picture from Beech 18 Flight Handbook*

***Note:*** *In another document, "EO 05-45B-1, Aircraft operating instructions for Expeditor" the minimum RPM for unfeather is 400-600 rpm, contradicting the 1000 rpm referred above. Cross checking this with other videos, Denarq mod uses 450 rpm as minumum rpm for a successful unfeather.*

UNFEATHERING

29 To unfeather the propeller proceed as follows:

(a) Feathering oil dilution switch - SUMMER position.

(b) Propeller - Fully coarse.

(c) Throttle - Closed.

(d) Mixture - Idle cut-off.

NOTE

If propeller has been feathered for more than 2 minutes, rotate the engine two revolutions with the starter before unfeathering.

(e) Ignition switches - ON.

(f) Generator - Charging on live engine.

(g) Fuel - Tank selector ON.

(h) Feathering button - Hold button in until 400 to 600 rpm is attained, then release.

(j) Mixture control - RICH.

(k) Generator switch - ON.

(m) Warm up engine at 15" MP and 1,500 rpm.

2-13

*Picture from "EO 05-45B-1, Aircraft operating instructions for Expeditor"*

**Important:**

-Prior to feather, if possible, set propeller pitch lever full back do increase propeller pitch angle in order to reduce time feather pumps are working. This could reduce electrical load under emergencies.

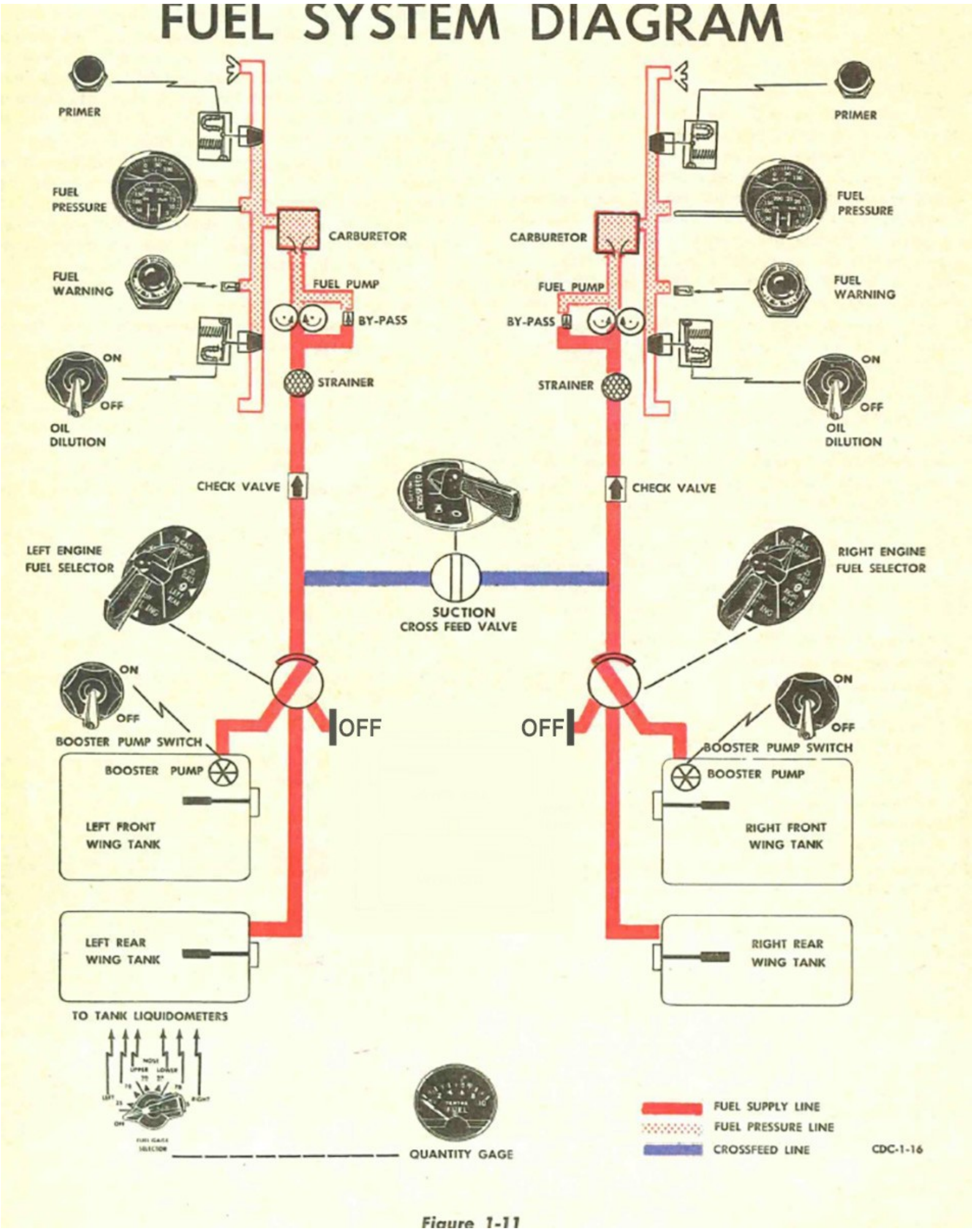
-To unfeather during flight, with engine off, aircraft speed could not be sufficient to windmill propeller to 450 rpm required to unfeather. In this case, set aircraft in a gentle descent in order to increase speed.

-Remember that with oil temperature below 40º, you shouldn't rev your engines over 1000/1100 rpm. In case of an engine restart during flight, use your propeller levers and throttle if necessary to keep engine RPM under control until oil is warmed.

## Fuel System

This mod now uses the Msfs2020 advanced modern Fuel system.

In Beech 18, each motor has its own individual fuel system, interconnected by a suction cross-feed valve. In each system there is a front fuel tank, which has a submerged electric fuel booster pump; and a rear fuel tank, both located in the wing root.



*Picture from Beech 18 Flight Handbook*

**Cross-Feed valve.**

SUCTION CROSS-FEED HANDLE.

The suction cross-feed handle (figure 1-13), located under the copilot's seat, is for use in those emergencies where it is necessary to operate both engines from the same tank or where it is necessary to operate one engine from the tanks in the other engine's fuel system. This cross-feed connects the two fuel supply systems up stream of the engine driven pumps.

*Picture from Beech 18 Flight Handbook*

**Important:**
**Cross-feed valve is not for fuel transfer between tanks. If handle is in "ON" position, one of the tanks selectors must be in "OFF" position.**

**Fuel Pumps.**

FUEL BOOSTER PUMPS SWITCHES.

Two electric fuel booster pumps are provided in the aircraft, one in each front (main) wing fuel tank. Individual booster pump switches (figure 1-7) on the left subpanel activate the electric fuel booster pumps. The pumps are provided to supply fuel under pressure to the carburetors for priming and starting, to supplement the engine driven pumps in an emergency and as a safety feature for take-offs and landings. The engine driven pump has a by-pass valve incorporated in it through which the fuel from the booster pump passes.

*Picture from Beech 18 Flight Handbook*


**Important:**
**To protect booster pumps, if the tank selector isn't on front tank position, fuel pump switch won't stay on. This is also valid if there isn't electric charge in the system.**

**Important:**
**Beech 18 engines require 1.4 PSI of fuel pressure for combustion. For this reason, electric fuel booster pumps are mandatory to engine start as well to ground operations and landing where low idle settings could lead to engine stop if only engine driven pumps are used. During takeoff, its use is advised to prevent engine shutdown due to engine pumps failure.**

**Fuel pumps failure**
Any of 4 fuel pumps, both engine driven or electrical pumps, can have a failure and stop working any time during flight.
Engine driven fuel pumps have their chances of fail increasing with time since last maintenance check and engine wear.
Electrical fuel pumps (aux booster pumps), being an electrical component have their chances of failure increasing with time since last maintenance check and extreme temperatures.
Temperatures above 30ºC and below freezing will increase their failure chance. The more extreme the temperature, the greater the likelihood of failure.

To check fuel pumps usage time or to perform a maintenance check use miniflo-L instrument, under maintenance mode (See chapter X, pag. 22).

**Fuel tanks usage.**
Because electric fuel pumps are inside front wing tanks, to be able to use them these are the tanks used on startup, ground operations, takeoff and landing.
To preserve fuel in these tanks, during cruise, if you have fuel in rear tanks is advised to switch to rear tanks and use their fuel first.

**Rear tanks limitation**
High nose attitude interfere with rear tanks fuel quantity measure instruments and the way fuel is feeded into the engine. Because of this, rear tanks use is only advised during level flight.

**Fuel pressure warning lights**
These lights, one for each engine, located in front instruments panel, light when fuel pressure drops below 2.5 psi. Below this, there is a risk of fuel starvation and engine shut off.

When tanks in use are almost empty, due to low fuel, pressure drops, so having these lights turned on could be a good reminder to change tanks in use. You should cross information with fuel quantity instrument to check if that is the case.

**Fuel quantity indicator gauge**
Every real pilot knows that fuel indicator needles give us good estimations, but aren´t to be totally trusted. They all have small errors.

In Denarq mod, each fuel tank measure instrument has a deviation or precision error. This error starts as a small one but is aggravated with flight time under turbulence. Every time the plane goes through turbulence, the floats inside the tanks that measure the fuel lose accuracy. So, over time, the indicator's accuracy decreases.

To add to this, flying without any fuel on rear tanks can permanently damage the measuring flots and this can prevent any fuel information to show on gauge.

To fix measuring flots, you can perform a maintenance reset with miniflo-L instrument, under maintenance mode (See chapter X, pag. 22). There, you can also see time of use since last maintenance.

## Electric System

Electrical power is supplied by two 28 volt 100 amp, engine driven generators, one on each engine and supplemented by two 24 volt batteries.

**Generators**
Generators don't have any master switches in cockpit. They are always in standby mode and enter online with engine running with RPMs above 1200.

Generators have lifetime and like in reality, the older they are the most likely they are to fail. With engine running above 1200RPM, if ammeter neddle is parked at zero position, than that means generator has probably failed and you need to perform a maintenance on it.

Being an electrical system, with extreme temperatures, below freezing (0ºC or 32ºF) or above 30ºC or 86ºF there is an increased chance of generators to fail and the extremist the temperature the higher the chance.

You can perform a maintenance check on each generators with miniflo-L instrument, under maintenance mode (See chapter X, pag. 22). There, you can also see time of use since last maintenance.

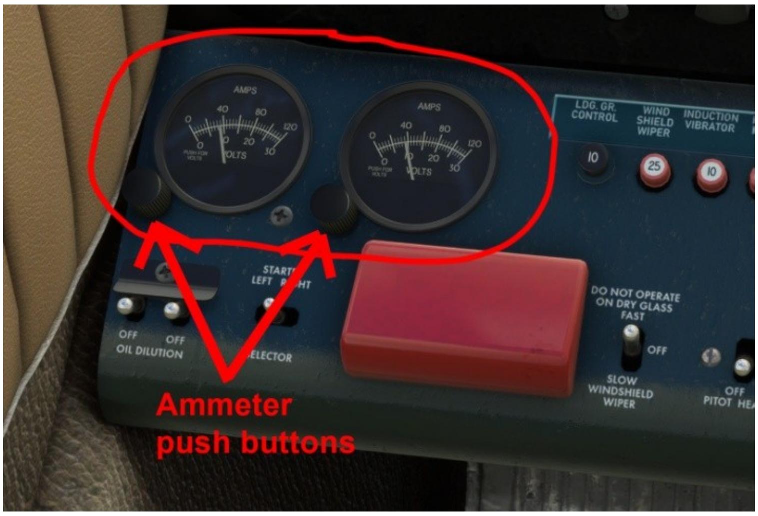
**Batteries**
Batteries have persistent voltage, meaning that their voltages is saved at the end of flight and is restored for next flight (if flight is started parked).

Like in reality, Denarq Beech batteries capacity gets diminished with cold temperatures.
So with temperatures below freezing is normal observe some battery behaviors:
-their voltage doesn't top at 24 volts.
-They depleted faster than with cold weather.
-They take more time to recharge.
So, in cold weather operations is advised to be very careful with electric systems.

**Recharge batteries**
Use miniflo-L instrument, under maintenance mode (See chapter X, pag. 22).

**Ammeters**
This plane has two ammeters on left side of front panel. One for each generator/battery. Without any additional action, they show generators electric load in percentage (upper scale of the arc).
-Zero means that generators are offline, so energy comes from battery.
-Anything in between zero and 100 is generator load with the remaining being supplied to recharge batteries.

-Above 100 - all their energy is being used and everything above 100 amps is being supplied by batteries so they are being depleted as well. Because ammeter reading tops at 120 amps, we can't know how much energy is being used from batteries if needle is at 120 amps.




If ammeter button is being depressed, the ammeter reading will show main bus voltage (lower scale of arc). You have to wait a few seconds so that needle tops at correct reading.

-With generators online should read 28 volts.

-Without generators, needle indicates batteries voltage. A full charge battery has 24 volts and any value below 24 indicates that batteries are not at their full capacity.

At the beginning of each flight, before engines start, you should check batteries voltage. 14 volts are the minimum required to operate the aircraft. If 14 volts or less is observed you need to change batteries.

**Some tips:**

-Before landing, and due to their high electric load and low RPMs environment, don't operate flaps and landing gear at the same time.

-During night operations, specially with cold weather, be very sparing when using electrical systems. Lights and anti-ice and heaters can increase a lot the plane electrical load. During descent and final approach, low RPMs could mean that generators aren't supplying energy so don't use any unnecessary lights.

-In order to ensure that its charge is full at the beginning of each flight, is advised to let engine running with RPMs above 1200 for a minute at the end of the flight, before switching off batteries so they can fully recharge.

-With one engine flight, one single generator couldn't be enough to supply sufficient energy to all electric systems. Is advised to keep generator load (ammeter) at 80% to keep batteries fully charged for final flights stages. To do so, turn off all not essential systems. Second radio, DME and NDB, interior lights and unnecessary heaters could be dismissed.

**NOTE**

Due to critical electrical power it is necessary, under instrument conditions, to maintain constant check on generator operation during flight. In the event of one generator failure or single engine operation, monitor the electrical output of the remaining generator. The electrical load should not exceed 0.8 on the loadmeter of the remaining generator. Do not rely on the generator overvoltage light as sole indication of generator failure. This light comes on only after an overvoltage condition. The loadmeters and voltmeter are the only reliable indication of generator operation.

## Oil System

This Denarq mod use a new scratch made oil system.

While default msfs sdk only allows oil temperatures and pressures and these are computed after engine calculations and therefore they don't have a direct effect on performance, with this new system oil is treated as something with substance that exists in aircraft and impacts on how plane behaves, not only mechanically but also how it flies.

The main items of Denarq oil system are:

-Oil quantity that is persistent between flights. You need to check and fill if necessary oil tanks prior any flight.

-Oil tanks placed on their correct real location that impacts not only oil behavior but also aircraft flight model according to their load.

-Oil temperature and pressure that not only derives from engine calculations but also contribute to.

-Oil consumption that match Pratt&Whitney engine real numbers crossing all range of engine operation and is influenced by engine wear.

-Oil leaks.

-Almost all instruments that are at disposal on real plane to deal with oil. Oil shutters, Oil bypass lever and oil shutoff valve. All of them with custom made code.

**Oil system overview.**

In Beech 18, like fuel, each motor has its own individual oil system. This oil is used for engine lubrication and propeller operation. Oil path starts on oil tanks. From there oil is supplied to engine through the oil pressure pump and then it returns to the oil tanks passing through the oil cooler.

**Oil tanks.**

Oil tanks are located on upper part of engine nacelles behind the engine.
Each tank has a capacity of 8 gallons of oil, of which 6.5 gallons are for engine and 1.5 gallons are for propeller operation.

<u>Minimum Oil quantity:</u> 4.7 gallons.
According to P&W, these engines require 3.2 oil gallons to normal operation. Adding 1.5 gallons to propeller operation, we get 4.7 gallons minimum. If oil quantity gets bellow this value, oil pressure starts to decrease and engine starts to overheat. This lead to engine wear and could lead to engine failure.

<u>Max oil quantity:</u> 7.5 gallons.
although there is 3 gallons room for expansion in oil system, real pilots reports that oil quantity shouldn't be more than 7.5 gallons in oil tanks. More than this could lead to increase in oil pressure and consequently to oil leaks.

You can check oil quantity in "weight and balance"  menu (*) under "Left/Right Oil tank" but their loads are locked. You can change fuel quantity using sliders or use any external application that change these values like "FSeconomy" but oil quantity wouldn't change.

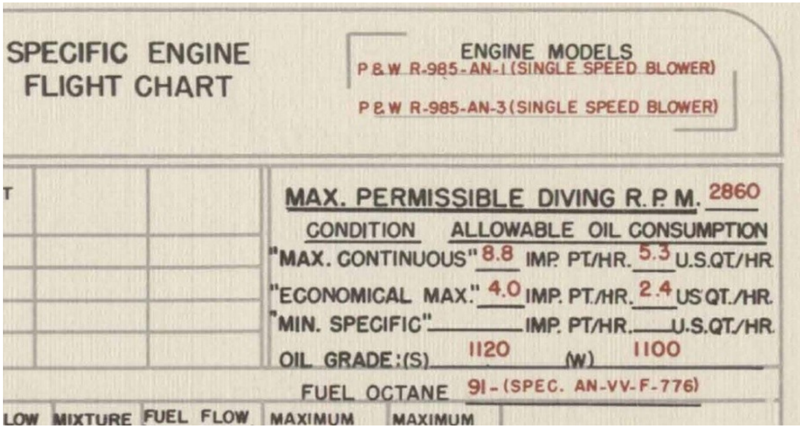

**(*) Important:**
**To check oil quantity you have to access "weight and balance" through upper menu inside cockpit. If you access  "weight and balance" through "World map" it will not work.**

**How to fill oil tanks**

Like in real aviation, checking oil quantity should be part of your pre-flight check list.
To fill tanks you need to pull L/R Oil shutoff levers, with plane stopped and engines off. Once done, you can adjust L/R oil tanks sliders. Then, just push oil shutoff levers in and you are ready to go.

### Oil consumption

According to Pratt & Whitney, R985 engines use around 1.3 gallons of oil per hour at max. continuous power and around 0.6 gallons at max. cruise power. At all other power settings oil usage is proportional to these values. In this mod, oil consumption increase with engine wear. For every 2 percent of engine wear there's an 1% increase of oil consumption.




### Oil quantity persistence

In this mod oil quantity is persistence between flight. This means that at the beginning of a flight aircraft oil tanks will have the same amount of oil that was at the end of previous flight.

But this only happens if you start your flight parked with engines of. If you start your flight on runway or flying, oil tanks will have the maximum correct oil quantity, 7.5 gallons. This is for those people who just want a fast flight and don't want to spend time with complex engine systems.

At the end of flight, if you want oil quantity to be saved for your next flight you have to stop the plane, switch off the engines and turn off the batteries. Only in these conditions, oil will be saved. If these conditions are not met then saved oil quantity will remain the same at beginning of flight.

### Oil temperature

Old radial piston engines are very sensitive to oil temperature.
Never operate the engines with RPMs above 1100 with oil temperatures below 40ºC (red line on oil gauge).
The viscosity of the oil depends on the temperature and below 40ºC the oil still does not have enough viscosity for correct engine lubrication.


Increase RPMs above 1100 with oil temperatures below 40ºc  will increase engine wear and will rise very fast cylinders temps due to low lubrication and you'll see MP needle started swinging around due to low lubrication of engine.

**Instruments to operate oil system.**

There are three instruments at pilot disposal to operate oil system in Beech 18 and hekp to manage oil temperatures:

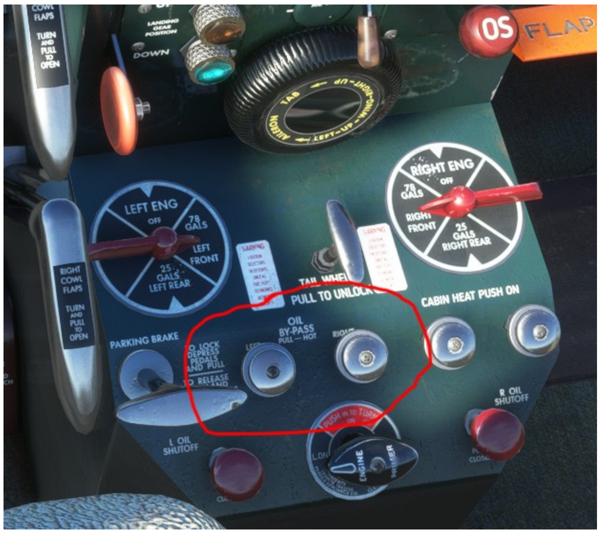
Oil shutters levers, oil bypass buttons and oil shutoff buttons.

**Oil bypass buttons:**

OIL BY-PASS BUTTONS.

The oil by-pass buttons (figure 1-5) on the pedestal are mechanically linked to the oil by-pass valves in the engine compartments. The controls are the push-pull type, incorporating an automatic position lock which should be released by depressing the center plunger when the control is repositioned. Pulling the button all the way out places the valve in the HOT oil (by-pass valve open) position, pushing it all the way in places the valve in the COLD oil (by-pass valve closed) position. The control has only two operating positions, full out or full in. Pulling the control out allows the oil to by-pass the coolers and flow from the engine directly to the oil supply tank for quicker warm-ups in cold weather and to maintain oil temperature during cold weather operation.

*Picture from Beech 18 Flight Handbook*

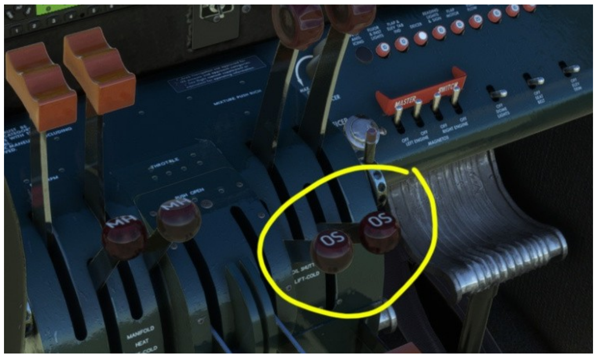



Because with oil bypass buttons, oil goes directly from engine to tank, bypassing cooler, if these buttons are pulled, oil shutter levers don't have any impact on oil temperatures. Because with oil bypass, oil is heated from engine, CHT (cylinders head temperatures) have a direct impact on oil temperatures rising. Oil temperature  will never be higher than CHT and the speed at which oil temperature rise is proportional to the difference in temperature between CHT and oil temps. This means than oil heating will slow as oil temperatures gets near CHT.

Use Oil bypass buttons, mainly to warm oil temperatures during startup on cold weather operations. Use this with caution and monitor oil temps closer. Usually is advised to push down bypass buttons as soon as oil temps gets to desired values.

**Oil shutters levers.**

"Located on pedestal, these levers are mechanically linked to the shutters, regulating the volume of air allowed to pass through the coolers. The full position of levers is the COLD position; full down position is the HOT position. The shutters may be set in any desired position through their full travel," and at their maximum HOT position they can get around 30ºC rise in oil temperature.



**Oil leaks**

There are oil leaks modeled in this system and they are a result of a probability calculation.

The probability of an oil leak essentially depends of the combination of two factors:

- The physics that are taking place in the operation of the engines
- Engine Wear.

About the physics, there 4 main triggers that can make an oil leak:

- Overboosting. Operating engine with manifold pressure over 36.5. The chances are proportional to manifold pressure.
- Oil pressures above 90 PSI. Again, probability is proportional to oil pressure.
- Operating the engine above max continuous power. Because this power setting is within what P&W allows to this engine, the chance of occurring an oil leak is very low and shouldn't be a reason not to use these power settings. But everyone must understand that forcing an engine near its max power is always prone to some degree of failure.
- Starting an engine with outside temperatures below freezing (0ºC or 32ºF) without oil bypass. Oil radiators have very small diameter pipes that are very prone to clogging due to ice particles in oil. Because of this, if external temperature is below freezing you should always open oil bypass lever prior to engine start and keep it until oil temperatures go above 20º. One oil temperature gets above this threshold, you can close oil bypass levers, even if external temperatures is low because all ice that could be in oil has already melted.

When an oil leak occurs, it will continue until oil is completed depleted from tanks until there are only 1.5 gallons left or the engine that has an oil leak is stopped.
The quantity of oil that is leaking during an oil leak is proportional to oil pressure so lowering engine power output is a valid way to slow down oil leak.

**Important**
**During an oil leak, until the quantity of oil in tanks is lower than 4.7 gallons, engines will keep running without any degradation of performance or changes in oil pressures. Because of this, once you notice a decrease of oil pressure or increase in cylinders temperatures, it means that oil is already bellow minimum. Rapid actions are required.**

**What to do during oil leaks.**
During oil leaks there are three valid options to better deal with oil leaks:
- If you are in the vicinity of a valid runway, land as soon as possible. Not any additional actions are required.
- If you are on a descent and within 10 to 20 minutes away from a valid runway, reduce power setting from engine that has an oil leak so you can decrease as much as possible oil pressure in this engine. Doing this, you are decreasing the speed that oil is depleting from system and therefore extending available time to run that engine. Land as soon as possible.
- If you are far away from a valid landing spot, shut down the engine with oil leak, never forgetting to feather propeller prior this. This away you are not only preventing a severe engine damage and stopping oil to be completed depleted from system but are have the possibility to later, prior to landing to turn ON your engine to have all available power to land. Remember, that under an one engine flight you need to adjust your rudder trim to keep ball centered.

## Engine settings (RPM and manifold pressure gages)

Even if you use engine settings below red line, there is a limited time in which you can use high power settings. Both these settings are modeled in this mod and using them more than restricted time would lead to engine wear and high CHTemps.

- Takeoff power, red line (around 1 minute).
- Climb power, yellow band (around 30 min).Altitude restrictions are also modeled

| | |
|---|---|
| Take Off Power | |
| Sea Level | 450 BHP - 36.5 in Hg. at 2300 RPM - Limit one minute |
| Meto Power | |
| Sea Level | 400 BHP - 34.5 in Hg. at 2200 RPM |
| 5000 ft. | 400 BHP - 33.5 in Hg. at 2200 RPM |

*Picture from U-09 Feb 1948-D Model Flight Manual-Beechcraft*

**Overboost**

Although these engines are rated to 36.5 inHg of Manifold pressure (red line in MP gauge), they can deliver more than that at low altitudes. In ideal conditions they can go over 41 inHg. Never use more than 36.5, meaning at low altitudes you can't takeoff using full power.

This is very important because doing so you are not only increasing engine wear and cylinders temps, using very high MP can damage or even ruin your engine in just a few seconds.

## Mixture

Fuel needs to be mixed with air in order to ignite. The ratio between this two shouldn't be too high towards to fuel side, otherwise it will not ignite and consequently flood the engine with unburned fuel; and shouldn't be to lean  or too much air because there isn't enough fuel to keep combustion and engine will stop.

To adjust  fuel-air ratio , there are two mixture levers on quadrant, one for each engine. Full foward position is the full rich position and it gets lean towards rear position. Cranking on botton end will cut fuel from engine stoping the combustion.

In Denarq mod, like in reality, mixture affect 3 main parameters of the engine: power output, fuel consumption and temperatures, both EGT and CHT.

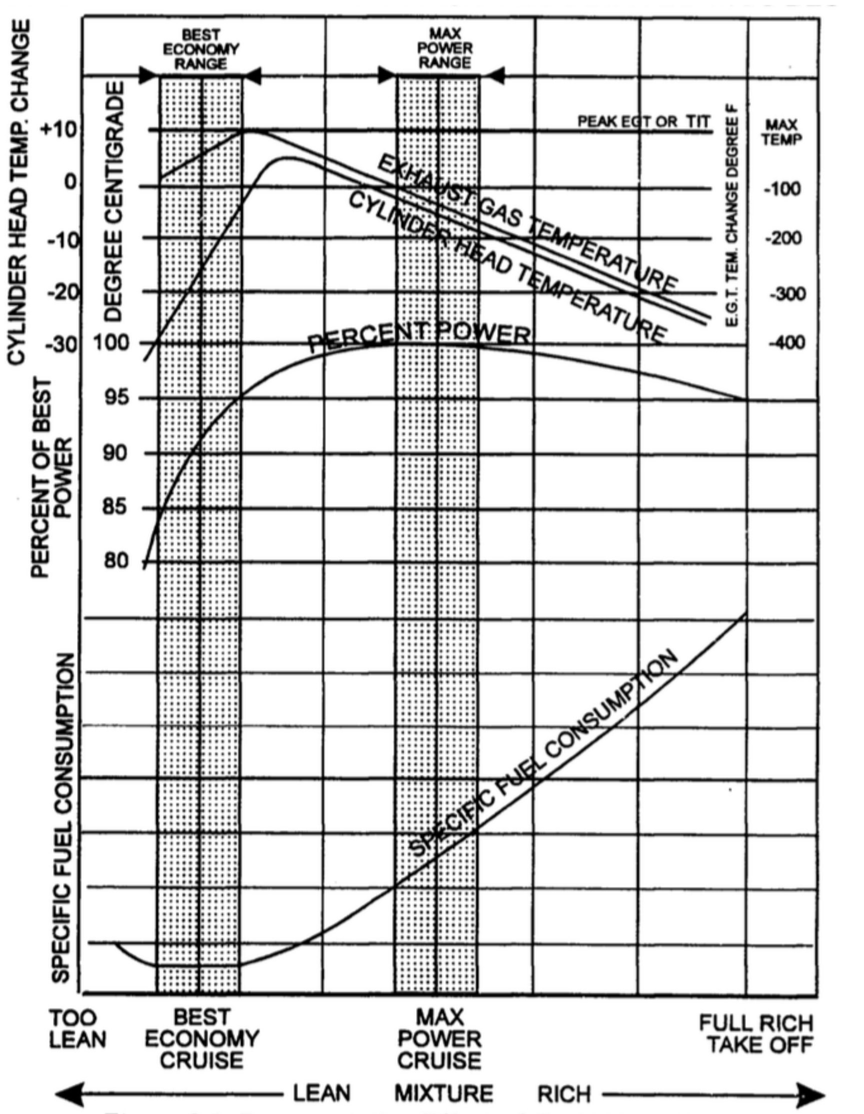


Figure 3-1. Representative Effect of Fuel/Air Ratio

*Generic graph showing relation between mixture, fuel consumption, power and temperatures on piston engines (not specific to Beech 18)*

**Power output**

With Pratt&Whitney radial engines, like the R985 of Beech 18, the relation power-mixture is well documented.

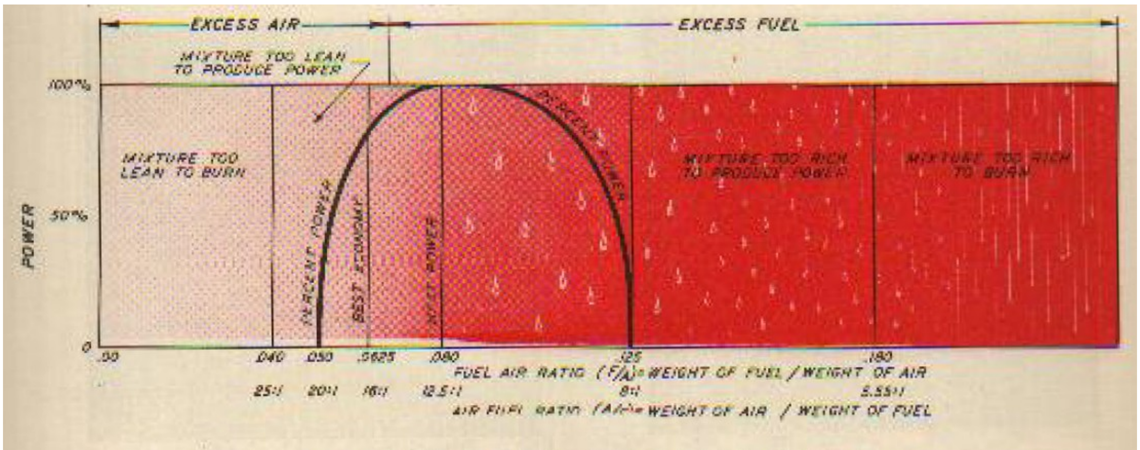



**Fig. 4 — Combustible Range of Fuel and Air Mixture**

*Picture from "The aircraft engine and its operation", 1955 by Pratt&Whitney.*

**Temperatures**

Cylinder head temperature: Mixture is one of the tools to control the cylinders head temperatures. With full rich mixture, the excessive fuel in cylinders will act as a coolant and because of this cylinders temperature will be lower. It's advised to use full rich during initial climb to keep CHT under control.

A lean setting, although with less fuel, will also give a low temperature combustion inside chamber and by this reason will also decrease CHT. All ranges between full rich and lean will follow the curve on previous page.

EGT: Exhaust gas temperature works as a window so we can see what is happening inside cylinders and allow us to adjust mixture. EGT is the main tool to adjust mixture and you can check in real time EGT with EGT indicator.


With full rich mixture, EGT is low. Then, as we lean the mixture, the EGT rises until it reach a peak and after that if we continue to lean it decreases again (see picture on previous page).

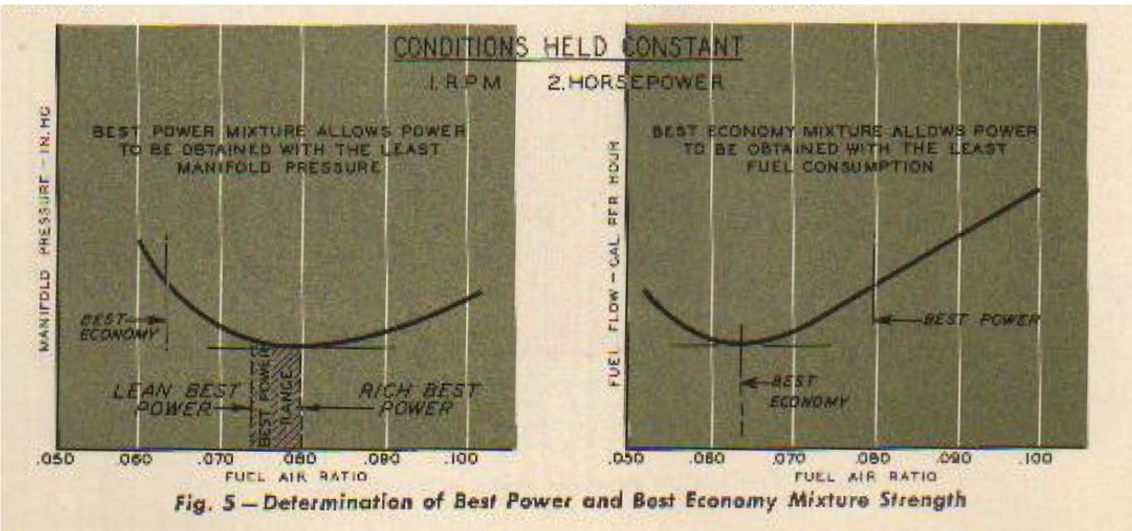
Everytime we adjust the mixture leaning from peak EGT is called lean of peak and if we adjust mixture richer than the peak is called rich of peak. Both are measured in degrees.

Ex: 50 degrees lean of peak. This mean we found EGT peak adjusting mixture and then we keep leaning until EGT drops 50º from peak.

The range around EGT peak should be avoided. In this range CHT are also very high and the ratio power/consumption is worst.

50º to around 120º lean of peak is the best economy range. This is the range where engine requires less fuel for the desirable power. If you want endurance or range, this is your mixture setting.

50º to 150º rich of peak is the best power range. It is in this range where engine is outputting the highest power.




*Picture from "The aircraft engine and its operation", 1955 by Pratt&Whitney.*

## Detonation

Detonation is modeled in Denarq mod.

Detonation doesn't refer to nothing that happens with engine but rather to what happens to fuel inside cylinder.

Under normal conditions, fuel ignition should occur in" a smooth orderly fashion starting at the spark plugs , starting at the spark plugs and progressing across the combustion chamber until it is quenched upon reaching the cylinder walls and piston crown when air-fuel charge has been completely consumed and there’s nothing more to burn. The combustion event takes a significant period of time – roughly 6 milliseconds or 90° of crankshaft rotation, give or take.

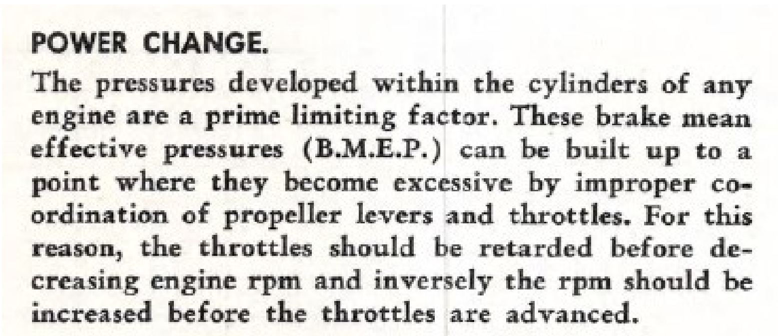
But if the combustion process moves too fast and the pressure peak occurs too early, the result can be excessive pressure, excessive temperatures, and unstable pressure pulses known as “detonation”."
*From: https://resources.savvyaviation.com/detonation-and-pre-ignition/*

**Detonation causes**
there are various reasons for detonation to occur. Although they are separate their contribution to detonation can overlap and there for increase level of detonation.

Light detonation is not very dangerous. It can occur for continuous amount of time. Although it will not break your engine, it increases its wear and reduces engine efficiency there for engine power.

- High CHT. High temperatures inside cylinder chamber can disrupt fuel ignition and lead to detonation. Usually, only very high temperatures can contribute to detonation, above 260ºC or 500ºF.

- Manifold pressure/RPM ratio. High manifold pressures require fast moving cylinders to cope with that pressure levels. If there is high pressure inside cylinder and the cylinders aren't moving fast enough, this could as well lead to detonation. For this reason when changing power RPM should always stay above MP. When reducing power first reduce throttle and then propeller pitch and when increasing power, first increase RPM with propeller pitch and then increase throttle.


**POWER CHANGE.**
The pressures developed within the cylinders of any engine are a prime limiting factor. These brake mean effective pressures (B.M.E.P.) can be built up to a point where they become excessive by improper co-ordination of propeller levers and throttles. For this reason, the throttles should be retarded before decreasing engine rpm and inversely the rpm should be increased before the throttles are advanced.

*Picture from Beech 18 Flight Handbook*

- Excessive leaning (see also Mixture ratio, pag. 22). Fuel needs to be mixed with air in order to ignite. The ratio between this two shouldn't be too high towards to fuel side, otherwise it will not ignite and consequently flood the engine with unburned fuel; and shouldn't be to lean or too much air because there isn't enough fuel to keep combustion and engine will stop. But before this extreme low fuel ratio is reached, there is a point where combustion still occur but not as it should but as detonation. In reality this is the main cause of detonation damage in engines. In this situation, slightly increase or carb. temps. can help reducing detonation.
This is why, when leaning you should always use EGT or using tradition old way.

**MANUAL LEANING.**

Since no exhaust gas analyzer is provided in the aircraft, the mixture must be leaned by procedure as outlined below.

Establish the desired rpm and manifold pressure.

Retard the mixture lever in small increments until an instantaneous drop of 25 rpm is noted. Advance the mixture lever to its last position prior to the sudden drop.

Under normal operating conditions, at altitudes of less than 5,000 feet, the mixture will not be leaned.

*Picture from Beech 18 Flight Handbook*

- High carburetor temperatures, above 15ºC or red line also lead to detonation. During very hot weather there is the possibility that carburetor temps are above this threshold no matter what. In this situation avoid high power settings as possible in order to help reducing detonation.

Above these previous reasons there are two factors that combined with previous reasons lead to final detonation level:
- Manifold pressure.
-Engine wear.

Even if one of the 4 reasons is occurring, reducing manifold pressure can help or even eliminate detonation. The same way, even under light detonation, increasing manifold pressure to high levels can aggravate the problem.

**How to detect Detonation and detonation consequences.**
There are four direct ways of detecting detonation.
-High CHT.
-Low EGT.
-Loss of power
-Rough running engine.

Unfortunately, under light detonation, engine doesn't show any signs roughness and other symptoms are practically imperceptible. Only pilot experience and knowledge of aircraft and correct procedures can help avoiding detonation.
The good news is that light detonation hardly damage the engine and lead to any serious problem. It will increase wear over time and decrease its efficiency none the less.

Moderate detonation aggravate the symptoms and rough running engine can also be observed, so it will be more obvious that fuel is detonating but at the same time aggravate the wear, the efficiency and after some time can lead to more serious problems like engine damage. In this situation rapid actions are required in order to stop detonation.
- Increase mixture
-Reduce carb. temps if possible.
-Pay attention to RPM/manifold pressure.
-Reduce manifold pressure as possible.

Severe detonation lead to pre-ignition and this will likely kill your engine is seconds. Never let the engine reach levels of severe detonation.

**Final notes on detonation.**
Detonation also aggravate with time. So a lightly detonation level can lead to a more serious situation over time, even if the pre-conditions stay the same.

Like all other calculations in Denarq mod, detonation is dynamic and progressive calculated. There isn't an on/off state. Everything is direct consequence of engine and ambient parameters and as so their calculation is also progressive. Its relation to engine wear is also proportional to detonation levels.

## Engines wear

-Every time you are operating aircraft out of its normal engine operating ranges, your are increasing engine wear.

-Engines are always wearing. Even if you do everything right, there is always some minimal wear like in real life. This continuous value increase engine wear 10% for every 100 hours of working engines. So if you notice some marginal wear increase, that is normal and expected. 1 hour flight gives 0.1% wear increase.

-Engine wear is separated by engines, meaning each engine has its own wear

-For now (this will change in future) engine wear doesn't have any damage associated.

-Engine wear ranges from 100% (new engine) to 0%

-From 95% and below there is a loss of engine performance proportional to the wear value. Although it is proportional, it is not directly proportional, meaning that 50% wear does not mean a 50% decrease in performance.

-Engine wear is persistent between flights but you have to save it by switching off battery 1.

-Engine wear is irreversible . There is nothing you can do other than resetting that can make engine wear decrease.

## Engines damage

-Engine damage is not persistent between flights.

-You can't watch engine damages any other way than normal using aircraft instruments and behavior

-You can reset engine damage the same way as engine wear.

-Each system has its own damage associated, like CHT, manifold pressure, etc. You can damage or even kill an engine with almost no wear. For example, if you overboost a new engine for long time you will damage or kill it even without any significant wear. This means that controlling wear does not guarantee a free damage engine.

-Every time you are damaging an engine you are also wearing it.

-There are 4 types of engine damage (for now):

- Catastrophic engine event. Engine dies. (irreversible)
- Partial engine damage event. Sudden loss of performance. ( irreversible)
- Decrease if capacity to resist overstressing operating range. (Could be irreversible or reversible depending of system causing it).
- Oil leak (see oil system pag. 15).

## Oil, cylinders and carburetor temperatures

Here are the temperatures in with you should always operate your engines:

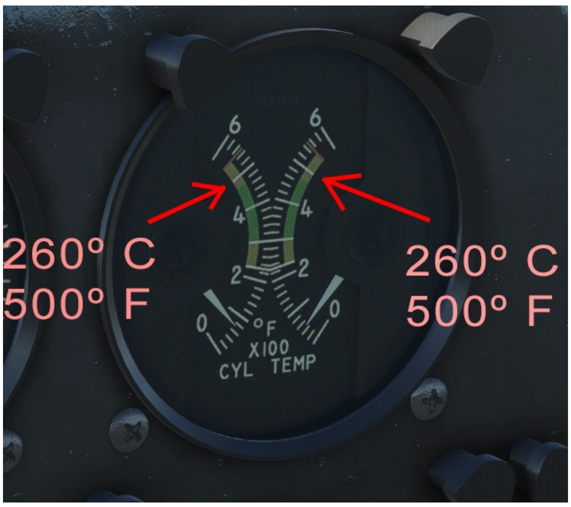
| | | |
|---|---|---|
| Oil Temperature | | |
| Minimum Allowable | 40° C | 104° F |
| Maximum Allowable | 93.3° C | 200° F |
| Cylinder Temperature | | |
| Minimum for Take-Off | 106.2° C | 225° F |
| Maximum Allowable | ~~286.6°~~ C 260 | ~~550~~° F 500 |
| Carburetor Mixture Thermometer | | |
| Icing Danger Region | -10° to 3° C | 14° - 37° F |

*Picture from U-09 Feb 1948-D Model Flight Manual-Beechcraft*

**Oil temperatures:**Oil temps under 40º was already explained. Over 93º adds to engine wear and at very high temperatures could lead to engine catastrophic event.

**Cylinder head temperatures:**
CHT (cylinder head temperatures) above 260ºC or 500ºF for a long time could lead to engine wear or even engine damage if for very long time. At higher temps could ruin your engine. Remember that at very high temperatures near or above red line) engine damage or worst could occur in just a few seconds.

Usually, there are 3 tools that can be used to control cylinders head temperatures:
-Cowl flaps.
-Speed.
-Mixtures (see mixture, pag. 26).




**Cowl flaps usage:**
Cowl flaps are used to cool down cylinders.

- Up position(open) during ground operations,

takeoff, landing and final.

- Down position (close) during flight.

Tip:
Speed is a much better cooler than cowl flaps, so in flight right after takeoff and all obstacles overcome, you can close cowl flaps. If your CHT is still to high, level flight to speed up and decrease your RPMs.

**Carburetor ice:**

With very low carburetor temps (yellow band and bellow), you may experience a sudden loss of power. Usually this occurs first at just one engine. If for no apparent reason one of the MP or RPM needles suddenly drops, this almost certain means ice on carburetor. Use Manifold Heat levers (Small levers between propeller levers with MH tag) to keep carburetor temperatures above 3º (green band).

Carburetor temps could get much lower than ambient temperature so even on ambient temperatures high above 0ºC always keep an eye on Carb temps.

Carburetor heat takes away some performance of your engines, so use them when you are not needing full power so you can build some temperature buffer. This way you can close them to take-off and land without worrying with ice on carburetor.


CARBURETOR ANTI-ICER.
Manifold heat on the aircraft will, to a degree, eliminate ice which has already formed in the carburetor throat; but it should be used as a preventive measure, rather than a corrective measure.
Take-off and landing should be made without using carburetor heat, but watch for a decrease in manifold pressure indicating carburetor ice and be prepared to use carburetor heat any time full power is not needed. Any use of carburetor heat will decrease the available horsepower.
While in icing conditions, operate the carburetor air doors frequently enough to keep ice broken off so they may be used as needed.

NOTE

If it is necessary to use manifold heat during the approach to landing, the manifold heat levers should be placed COLD prior to landing. This should be accomplished at the time propeller levers are positioned for TAKE-OFF RPM. Manifold heat levers are managed in this fashion so that full power will be available for go-around if the landing cannot be completed.

*Pictures from Beech 18 Flight Handbook*

## Miniflo-L

**Digital fuel Management system, Denarq systems maintenance and debug tool**


Miniflo-L is a digital fuel management system designed to provide complete fuel management information under real flight conditions without any manual entry of data (after entry of the initial fuel on board information).

With Denarq mod, in addition to functioning as a fuel system, the functionalities of this instrument have been expanded and now it works as an interface to system failures and wear and also as a debug tool.

Its operation is now divided into 3 modes:

- **Fuel Management mode**: Standard fuel management functionality of the real instrument.

-**Maintenance mode**: Interface with aircraft systems and its states like engine wear, system failures and time of use.

-**Debug mode**: A tool where you can review after each flight some of the engine parameters achieved during flight like detonation, max manifold pressure, time above overboost, oil leaks and its causes aswell an option to trigger an oil leak for training purposes.

**Intrument Layout**


1 - Left display
2 - Right Display
3 - SELECTOR knob
4 - ENTER TEST button (INOP)
5 - GAL.REM. button
6 - FULL FUEL button
7 - ADD FUEL button

**Navigate between each mode, sub-mode and pages.**
Each mode can have one or more sub-modes and each sub-mode can have up to 4 pages.

- Long press *on* ADD FUEL *button* (depress more than 1 second): Cycle between each mode *.
- Short press on ADD FUEL *button:* Cycle between each sub-mode *.
- *Selector knob* positions: Select different pages for every sub-mode.

* - There is one exception for ADD FUEL *button usage when on "ADD fuel sub-mode". See* Fuel Management mode (pag. 33).

**FUEL MANAGEMENT MODE**
This is the primary mode in which this instrument mimics its real counterpart.

Usually, on this mode, the left display will show total fuel flow in real time and right display will show different data depending function selected.

In order to have all data required to provide all information this system is capable of, we need to manually enter the fuel quantity in fuel tanks.

**Enter fuel quantity. "ADD" sub-mode.**
- Short press on ADD FUEL *button: Enter the "ADD" sub-mode."ADD" is displayed on left display.*

*On right display, the manual entered fuel quantity in gallons.*
*In this sub-mode the buttons functions are:*
- Long press *on Add Fuel button*: continuously increase fuel quantity at a fast pace .
- Short press on *Add Fuel button:* increase fuel quantity by 1 gallon.
- Short press on Full fuel button: Adds 206 gallons of fuel (Max for this plane configuration).
- Long press *on Gal. Rem. button*: continuously decrease fuel quantity at a fast pace.
- Short press on *Gal. Rem. button:* decrease fuel quantity by 1 gallon.

*To exit this sub-mode to main mode just wait 8 seconds without depressing any button.*
Fuel quantity is now manually entered and doesn't require any addition confirmation.

Notes:
-The fuel quantity entered in this instrument doesn't interfere with real fuel in aircraft tanks.
-This fuel quantity number is only used for this instrument calculations.
-You can enter any number you want between 0 and 206. It doesn't have the be the same as real fuel in tanks. Of course, calculations will based this number.
-You can update this number at any moment during flight, but as a good method and in order to perfectly match the real fuel quantity is advised to enter before engines start.
-Due to the way this instrument is coded in Denarq mode, if you change fuel load in your aircraft during flight, it will mess with this instrument calculations. In that case, the fix is just to update the fuel quantity enter in this instrument with "ADD" sub-mode.

**Main functions (right display):**

1.1.**Specific range**: With knob in "NM/GAL" position, the nautical miles per gallons is displayed. This is an indication of how efficient the cruise is and the optimum cruise speed can be determined by selecting the power setting, which yields the highest nautical miles per gallon.

1.2.**Fuel to destination**: With knob in "GAL. TO DESTINATION" position, the fuel necessary to reach the destination. This destination is the selected GPS way point if GPS is in GPS mode or the selected VOR if in GLock mode.

1.3. **Fuel Reserve**: With knob in "GAL. RESERVE" position, the fuel remaining in tanks after destination is reached. This feature provides the pilot with accurate information so that the reserve fuel situation can be evaluated and action can be taken if necessary.

1.4. **Endurance**: With knob in "MIN. ENDURANCE" position, Miniflo-L™ calculates the time left to fly in hours and minutes based on the fuel remaining and the present fuel flow.

Notes: All these 4 functions are real-time based on current speed and fuel flow and will change accordingly.

**Secondary functions (right display):**

2.1. **Fuel Remaining**: Short press on "GAL.REM" button will show on right display for 5 seconds total of fuel remaining in tanks.

2.2. **Fuel used**: Short press on "Full fuel" button will show on right display for 5 seconds fuel used since manual fuel quantity was entered in computer. Any change in "ADD" mode entered will reset fuel used information.

**Fuel Flow functions:**

3.1.**Combined fuel flow**: By default, left display will always show total fuel flow of both engines.

3.2.**Separate left and right Fuel Flow**: Long press on "GAL.REM" button will toggle the combined and separate left/right fuel flow.
In Left/right fuel flow mode left display will show left engine fuel flow and right display will show right engine fuel flow (Gallons per hour).
**important:** In this separate fuel flow mode, none of others functions will be displayed.

**Warnings:**

4.1. **Low Fuel Remaining**: The system displays “LOW FUEL” when the fuel remaining reaches the pre-programmed Low Fuel Level configured in "Denarq_Custom_Controls.xml" file* (25 gallons by default). Fuel flow or any other information will not be displayed again until the pilot acknowledges this message by pressing the "Full fuel" button.

4.2. **Low Endurance**: When the rotary switch is in the ENDURANCE position, and the actual endurance is less than the pre-programmed Endurance Warning Time* (30 minutes by default), the data in the right half of the display flashes.

4.3. **Not enough Fuel**: When the rotary switch is in FUEL TO DESTINATION position, the information in the display window flashes if fuel on board is insufficient to reach the destination selected. Display window shows amount of fuel short to reach destination preceded by a negative sign.

4.4. **Reserve Fuel will be used**: With the rotary switch in the FUEL RESERVE position, the information in the display window flashes if the aircraft will arrive at the destination with less than the pre-programmed Endurance Warning Time minutes of fuel *– calculated at the present cruise power setting. This warning is intended to alert the pilot that the prevailing condition will require the use of some of the selected reserve fuel to reach the destination.
If fuel on board is insufficient to reach the destination selected, display window shows amount of fuel short to reach destination preceded by a negative sign.

*** - Pre-Program Low Fuel Level and Endurance Warning Time.**
Like in real Miniflo-L instrument, it is possible to pre-program both Low Fuel Level and Endurance Warning Time.
Inside mod folder,
Denarq-enhancement-Beech-D18S\ModelBehaviorDefs\Carenado\Common\
is a file "Denarq_Custom_Controls.xml". This file can be edited with Nopad++.

In lines 13 and 14 are the code:
"30 (>L:Denarq_Custom_FUELENDURANCE)
25 (>L:Denarq_Custom_FUELRESERVE)"

You can change 30 (line 13) for Endurance Warning time in seconds and "25" (line 14) for Low Fuel Level in gallons.
**Very Important:** Edit only the numbers and keep existing formatting and spaces.

## MAINTENANCE MODE

In this mode we can check the integrity and usage time of all systems that may be subject to failures on the Beech as well as carry out repairs.

When in this mode, the right display characters color change to orange.
This mode is organized in sub-modes and each sub-mode has four pages selected with SELECTOR knob.
The left display will always shows the system designation and right display shows the system time of use, voltage charge or wear level, depending of system selected.
With Denarq mod, all systems referred in maintenance mode are persistent.

### Sub-mode 1

Page 1: WEAR 1
-Level in percentage of engine 1 wear. 100 is new engine with no WEAR.
wear depends on the hours the engine is used but also on the way we manage the engine.
Wear affects all parameters regarding engines like temperatures, performance, fuel and oil consumption, prone to failures, etc.
FULL FUEL button: Reset engine 1 wear to 100 and engine hours to zero.

Page 2: WEAR 2
-Same as page 1 but for engine 2.

Page 3:  ENG 1
-Engine 1 time of use. Format hours:minutes.
FULL FUEL button: Same as page 1.

Page 4:  ENG 2
-Same as page 3 but for engine 2.

### Sub-mode 2

Page 1: BAT 1
-Voltage of battery 1. Max voltage is 24.
FULL FUEL button: Recharge battery 1 to 24 volts.

Page 2: BAT 2
-Same as page 1 but for battery 2.

Page 3: GEN1
-Generator 1 time of use. It affects chance of failure. Being an electrical system, failure chance also increase with extreme temperatures.
Temperatures below the freezing point or above 35ºC increase the chance of failure. The more extreme, the greater the probability. Format hours:minutes .
If generator 1 has failed, right display shows "FAIL" message.
FULL FUEL button: Repair generator 1 and resets its time of use.

Page 4: GEN2
-Same as page 3 but for generator 2.

**Sub-mode 3**

Page 1: PUMP 1

-Engine 1 electrical boost pump time of use. It affects chance of failure. Being an electrical system, failure chance also increase with extreme temperatures.

Temperatures below the freezing point or above 35ºC increase the chance of failure. The more extreme, the greater the probability. Format hours:minutes .

If engine 1 electrical boost pump has failed, right display shows "FAIL" message.

FULL FUEL button: Repair Engine 1 electrical boost pump and resets its time of use to zero.

Page 2: PUMP 2

-Same as page 1 but Engine 2 electrical boost pump.

Page 3: PUMP 3

-Engine 1 engine driven fuel pump time of use. It affects chance of failure.

Engine 1 wear also affects chance of failure.

If engine 1 engine driven pump has failed, right display shows "FAIL" message.

FULL FUEL button: Repair Engine 1 engine driven pump and resets its time of use to zero.

Page 4: PUMP 4

-Same as page 3 but Engine 2 engine driven pump.

**Sub-mode 4**

Page 1: TNK 1

-Left front tank fuel quantity gauge time since last repair.

Fuel quantity gauges are very prone to damage, affecting its precision. With turbulence they tend to loose precision. If aircraft is in flight and tank is completely empty, turbulence may completely  damage tanks floaters preventing fuel quantity gauge to function.Format hours:minutes .

If floater is completely damage, right display shows "FAIL" message.

FULL FUEL button: Repair Left front tank fuel quantity gauge restoring its precision and resets time since last repair.

Page 2: TNK 2

-Same as page 1 but for right front tank fuel quantity gauge.

Page 3: TNK 3

-Same as page 1 but for left rear tank fuel quantity gauge.

Page 4: TNK 4

-Same as page 1 but for right rear tank fuel quantity gauge.

### DEBUG MODE

This mode is intended to work as a log tool where we can check some of the engines parameter achieved during flight. This could be useful, in case of abnormal engine behavior to identify possible causes.
This mode also have a special tool to manual trigger an oil leak for training purposes.
When in this mode, the right display characters color change to yellow.
This mode is organized in sub-modes and each sub-mode has four pages selected with SELECTOR knob.

#### Sub-mode 1

Page 1: MP1
-Maximum engine 1 manifold pressure achieved since flight start.
Units: Inches of mercury (inHg)

Page 2: MP2
-Same as page 1 but for engine 2.

Page 3: OB1
-Total time in seconds that engine 1 manifold pressure was overboosting (above 36.5 inHg)

Page 4: OB2
-Same as page 1 but for engine 2.

#### Sub-mode 2

Page 1: DET1
- Maximum engine 1 detonation level achieved since flight start (see pag.25, Detonation chapter for more information on detonation).

Detonation levels:
-1.00: No detonation
-1.00 to 2.50: Light detonation. Engine can sustain long periods with light detonation without failing, but engine Wear will increase faster. CHT will increase a little and EGT will decrease a little.
2.5-6.00: Moderate detonation. Engine cannot sustain these levels of detonations for more than a few seconds. CHT will increase faster and EGT will decrease faster as well. Can lead to engine failure.
above 6.0: Severe detonation and Pre-Ignition. Engine will die in a matter of seconds.

Page 2: DET2
-Same as page 1 but for engine 2.

Page 3: D.TM1
-Total time in seconds that engine 1 was in detonation (above 1.00).

Page 2: D.TM2
-Same as page 1 but for engine 2.

### Sub-mode 3

This sub-mode pages refer to **engine 1** detonation individual contributing factors. Final detonation is a sum of all these factor multiplied by a manifold pressure coefficient.
(see pag.25, Detonation chapter for more information on detonation).
Detonations levels same as in Sub-mode 2 (Pag.37).

Page1: D.RAT
-RPM/Manifold ratio detonation contributing factor. Low RPM with high manifold pressure will increase this (Pag. 26).

Page2: D.MIX
-Mixture detonation contributing factor (Pag. 26).

Page3: D.CAR
-High carburetor temperature detonation contributing factor (Pag. 27).

Page 4: D:CHT
-Cylinder head temperature detonation contributing factor (Pag. 26).

### Sub-mode 4

Sub-mode 4 is exactly the same as sub-mode 3 but refers to **engine 2**.
All pages left display displays the same text as sub-mode 3 and you have to count the times you cycled sub-mode to know if sub-mode 3 or 4 is active.

### Sub-mode 5

Page1: LEAK1
-In case of an oil leak in engine 1, this page will show the cause of it. (See pag. 20 for oil leak causes).
**Legend:**
----: No oil leak
RAD: Oil leak caused by ice in radiator.
OB: Oil leak caused by manifold pressure above max (36.5). Overboosting.
MAX: Oil leak caused by engine settings above max. continuous power.
PRES: Oil leak caused oil pressure above max (90Psi).

Page2: LEAK2
-Same as page 1 but for engine 2 oil leak.

Page3: TRIG1
-Special tool to allow a manual engine 1 oil leak trigger for training purposes.
FULL FUEL button: Activate an oil leak for engine 1.
Legend:
----: No oil leak
ACTIV: A manual triggered oil leak is active.
**IMPORTANT: Once activated, the oil leak cannot be stopped. It isn't persistent between flights.**

Page4: TRIG2
-The same as page 3,, but for engine 2.

## Checklists

**Reset engine Wear, recharge batteries or repair systems**
See Pag.35, maintenance mode of Miniflo-L.

**Before engines start**
( all payload adjustments, fuel, oil and cargo must be performed with upper menu already inside cockpit)

- Check fuel quantity and fill as needed.
- Check oil quantity and fill as needed (pag. 7 - 8)
- Check and adjust center of gravity (pag. 3).
- All switches off
- Left and right oil shutoff levers closed (push down).
- Crossfeed valve off ( under right seat)
- Parking brakes on.
- Tail wheel lock
- Batteries ON
- Check batteries voltage (pag. 8-9).
- Enter fuel quantity in Miniflo-L (pag. 32).

**Engines start**
To startup engines remember that with this mod priming is required.

Left engine

- Propeller and mixture levers full forward. (with airfields above 5000 ft some mixture leaning can be required).
- Throttle lever one inch forward
- Tank selector left front
- Cowl Flaps OPEN
- Oil bypass - as req. (Pull on cold weather and monitor oil temps after, close once oil temps are at 40º)
- Turn on nav. lights on steady.
- Left Fuel Booster pump ON
- Left Magnetos ON
- Starter selector and prime knob towards the engine you want to start.
- 4 or 5 pulls on prime knob (on very cold weather 6 or 8 pulls).
- push starter
- Use throttle lever to keep RPM below 1100 rpm. 800 to 1000rpm is advised.
- Turn off left Fuel booster  pump.

Right engine (Same procedures of left engine).

**Important:**
**Old booster button near starter button is for now "INOP".**

**Warm up**

- Lean mixture to max rpm (keep this setting for ground operations until entering runway.
- Adjust manifold heat levers to keep carburetor temperatures inside green arc.
- Monitor engines rpm and adjust, using throttle, to keep bellow 1100 until oil is at 40ºc
- Use oil shutters levers or oil bypass levers to speed up oil temperature increase <u>(oil bypass is only advised on very cold weather and requires precise monitor to close as soon as oil is at temperature)</u>.
- Don't turn ON any electric system other than minimal required (like NAV lights) until your Generators are online *. Doing so will deploy battery charge.
- Adjust elevator trim according to center of gravity (pag. 12 - 13)

* - You can turn ON engine Generators but they don't get online with RPMs below 1200.

**CAUTION**

Since the generators are not operative at warm-up rpm, the radio check is to be accomplished on external power. If engines are warm and there is a possibility of over-heating, this check may be made prior to starting.

7. Retard throttle to 900 rpm.

8. As engine speed decreases, the generator control circuit should disconnect the generator. This should occur at approximately 1000 rpm and will be indicated by a sudden "drop-off" of the volt and loadmeters.

9. Advance throttle on the right engine to 1900 rpm.

10. Observe volt and loadmeters — generators should reconnect at approximately 1200 rpm.

11. Lower flaps approximately 25 degrees. While

*From Beech 18 Flight Handbook*

**Taxi**

- Increase engine RPM to around 1300 and check generator is online (ammeter comes alive).
- Adjust mixture to max. RPM.
- Turn on master instruments switch.
- Turn on transponder.
- Set all frequencies, GPS and any navigation instrument as required.
- Turn on  beacon light.
- Adjust anti-ice systems and cabin heat as required.
- Turn-on fuel booster pumps.
- request taxi clearance.
- parking brakes off
- Unlock rear wheel (due to msfs2020 limitation on free castering wheel, you can use rear wheel lock during taxi to keep aircraft centered on straights).
- If free castering wheel is in use, use primary differential toe brakes and differential throttle to steer.

Tip: Use and abuse of tail wheel lock. This will stop you aircraft from spinning. Unless you need to turn, always keep it locked, even on straight taxi ways.

**Before take-off pre-flight check**

- Check ice on carburetor. Increase manifold heat by pulling down levers until carburetor temperatures are on the upper part of green arc. RPM should decrease. If RPM increase, means there is ice on carburetor. Don't turn off manifold heat until RPMs have stabilized.
- Both engines at idle speed. Check 500 RPM.
- Advance both engines to warm-up RPM.
- Check magnetos by turning off one at a time. No more than 100 RPM drop should be observed.
- Advance both engines to 1950 RPM. Manifold pressure gage should indicate your airfield barometric pressure plus or minus 1 inch Hg.
- Check oil temperatures and pressure.
- Check CHT.
- Manifold heat - COLD (full forward position).
- Check elevator trim.
- Check Oil by-pass levers - CLOSED.
- Check fuel pumps are ON.

**Take-off**

- Landing lights - ON
- Beacon light ON
- Check Oil by-pass levers - CLOSED.
- Nav. light intermittent.
- Flaps up (On very shorts runways, 15º flaps).
- Tail wheel locked.
- Manifold heat OFF - levers full forward.
- Elevator trim set.
- Pitot heat ON.
- Mixture full rich (below 5000 ft). Adjust for runways at altitudes above 5000 ft.
- Propeller pitch - FULL FOWARD.
- With cross-wind adjust rudder trim as required.
- slowly increase throttle. Never exceed 36.6 manifold pressure.
- Until tail is down, use differential power or differential toe brakes to steer.
- Tail wheel should lift at around 40 knots. Be prepared to react with rudder to keep center line.
- Use positive input to rotate at around 90 kn.
- Apply wheel brakes to stop wheel rotation.
- Landing gear up.
- Landing lights OFF and retracted.

**Climb**

- Keep Max. power until all obstacles are cleared.
- Switch OFF fuel pumps above 2000ft.
- Adjust elevator trim to climb.
- Reduce to max. continuous power or climb power.
- Cowl flaps off. During flight, speed is a much better cooler than cowl-flaps. Cowl-flaps drag decrease speed by about 8kn. Always prefer speed over cowl-flaps unless it is impossible to manage CHT. Some extreme situations like long climbs at low speed may require cowl-flaps.
- Keep full rich mixture to help on high CHT. Once CHT is controlled you can start the leaning procedure as required. Keep adjusting during climb.
- Adjust manifold heat to keep carburetor temperatures inside green arc.

**Cruise**

- Adjust mixture to cruise. EGT 50ºc to 100ºC lean of peak should give best economical settings.
- Check oil and fuel temperatures and pressure.
- Tanks selector - rear tanks if possible.
- Adjust manifold heat to keep carburetor temperatures inside green arc.
- Every 10 to 15 minutes is advised to perform a reset on carburetor ice: Increase manifold heat so carburetor temperature rises a little above red-line for a couple of seconds and then adjust back to green arc. This will brake any ice that could be forming in carburetor.
- When rear tanks are almost empty, change to main tanks.

**Descent**

- Front mains fuel tanks
- Adjust mixture to descent. Given that altitude is decreasing is better to adjust for richer settings in order to avoid detonation. Below 5000 ft full rich setting can be used.
- Set power to descent (be careful to avoid overspeed).
- Adjust manifold heat to keep carburetor temps on the upper half of green arc (7-14ºC).
- Unnecessary interior lights OFF

**Final**

- Check rear landing lock is locked.
- Mixture full rich.
- Propeller pitch - High RPMs, from 2000 to 2300 RPM.
- Gear down. (below 130 kt). Gears down can be used to reduce speed, but usualle they only lock in down position under 110 kn.
- Flaps - 30º and 45º before landing once runway is secured. (below 110 kt).
- Landing light ON. (below 100 kn).
- Carburetor temps. on green.
- Cowl-flaps open.
- Elevator trim for neutral pitch input as possible.
- Throttle target for 100 kt to 90 kt on final stage of "final".

**Landing**

- Propeller pitch full forward.
- Manifold heat - OFF
- Throttle - Idle over runway.
- touch down at 80 kt.

**Taxi**

- Tail wheel unlocked.
- Landing lights OFF (unless night operations and airport permit).
- Mixture lean to max. RPM.
- Pitot heat OFF
- Nav. lights steady.
- Beacon light OFF.

**Shut OFF**

- Parking brakes set.
- Panel lights OFF
- Instruments master OFF
- DME radio, COM2 radio and transponder OFF.
- Fuel pumps OFF
- Engine Rev engine for above 1200 RPM for 30 seconds to 1 minute.
- Check alternators are online.
- Shut down the engine with mixture.
- Magnetos OFF
- Throttle and propeller pitch levers full back.
- Tanks selectors  OFF
- Manifold heat and Oil shutter levers full forward.
- All lights OFF
- Cowl-flaps closed.
- Batteries OFF (This will trigger persistent variables to save for next flight).

## Custom Simvars and Localvars

Throttle (RANGE FROM 0 TO 1)
-**THROTTLE1_SET** (LVAR)
-**THROTTLE2_SET** (LVAR)

Manifold Heat: (RANGE FROM 0 TO 16384)
ANTI-ICE-GRADUAL-SET-**ENG1**
ANTI-ICE-GRADUAL-SET-**ENG1**

Starter selector: (Left-Center-right)
**CARVAR_SW_STARTER_LR** (LVAR) - (0-1-2)

Primer knob: (Left-Center-right)
**CARVAR_SW_PRIMER_LR** (LVAR) - (0-1-2)

Oil shutters levers: (RANGE FROM 0 TO 100)
**Denarq_OILSHUTTER_SET_1**
**Denarq_OILSHUTTER_SET_2**

Oil bypass buttons ( ON/OFF-0/1)
**Denarq_OilBypass_1**
**Denarq_OilBypass_2**

Fuel Tank Selectors

- Left front:
  **Denaq_Fuel_Sel1** - (1)
  **FUELSYSTEM_JUNCTION_SET (1,1)** (Event ID)
- Left Right:
  **Denaq_Fuel_Sel1** - (2)
  **FUELSYSTEM_JUNCTION_SET (1,2)** (Event ID)
- Left OFF
  **Denaq_Fuel_Sel1** - (0)
  **FUELSYSTEM_JUNCTION_SET (1,3)** (Event ID)

- Right front:
  **Denaq_Fuel_Sel2** - (1)
  **FUELSYSTEM_JUNCTION_SET (2,1)** (Event ID)
- Right Right:
  **Denaq_Fuel_Sel2** - (2)
  **FUELSYSTEM_JUNCTION_SET (2,2)** (Event ID)
- Right OFF
  **Denaq_Fuel_Sel2** - (0)
  **FUELSYSTEM_JUNCTION_SET (1,3)** (Event ID)

Cross-Feed Valve ( ON/OFF-0/1)
**DENARQ_CROSSFEED** (0/1)

Inst Light Master (overhead panel):
Switch ON
**VAR_SW_MASTER_INST_LIGHT** (LVAR) - 1
**CIRCUIT SWITCH ON:18** - 1
**CIRCUIT SWITCH ON:52** - 1
**CIRCUIT SWITCH ON:53** - 1
**CIRCUIT SWITCH ON:54** - 1
Switch OFF
**VAR_SW_MASTER_INST_LIGHT** (LVAR) - 0
**CIRCUIT SWITCH ON:18** - 0
**CIRCUIT SWITCH ON:52** - 0
**CIRCUIT SWITCH ON:53** - 0
**CIRCUIT SWITCH ON:54** - 0

Dimmers: (L.H. PANEL-ENG INST-RADIO-R.H. PANEL)
**CONTROL LIGHT-POTENTIOMETER_5_SET** - 0 TO 100
**CONTROL LIGHT-POTENTIOMETER_3_SET** - 0 TO 100
**CONTROL LIGHT-POTENTIOMETER_4_SET** - 0 TO 100
**CONTROL LIGHT-POTENTIOMETER_6_SET** - 0 TO 100

Compass light:
**CONTROL LIGHT-POTENTIOMETER_7_SET** - 0 TO 100

Landing light:
Off and retracted
**XMLVAR_LANDINGRETRACTSTATE** (LVAR) - 2
Off and out
**XMLVAR_LANDINGRETRACTSTATE** (LVAR) - 1
On and out
**XMLVAR_LANDINGRETRACTSTATE** (LVAR) - 0

* state.CFG location (steam version):
C:\Users\[USERNAME]\AppData\Roaming\Microsoft Flight Simulator\SimObjects\Airplanes\MSCarenado_D18S