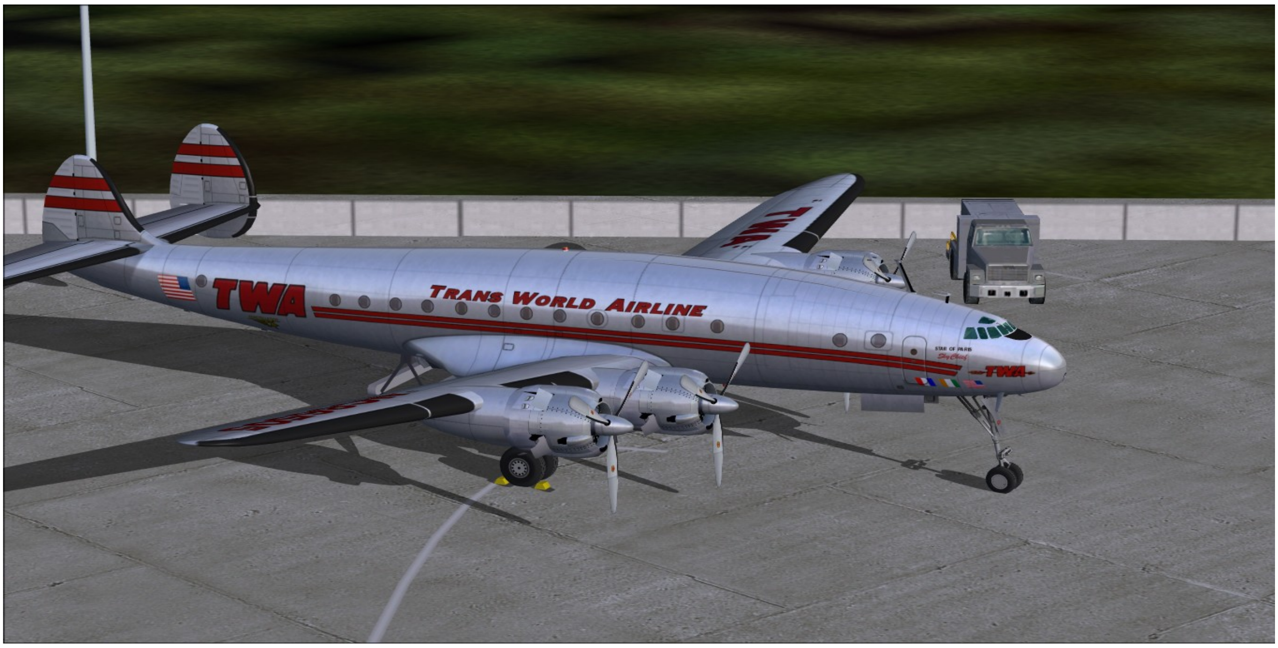
Lockheed L-49 Constellation Manual
for Flight Simulator 9



Contents

1. Flying the Lockheed L-49 Constellation

This Lockheed L-49 Constellation for use in FS9 complements the series of Constellation types previously released by this team and fills the gap left – the aircraft that started it all in the first place. The visual model displays new engines and also includes a complete VC showing some differences to the layout in later, versions, particularly the center pedestal and the autopilot installation. Cockpit layout and flight dynamics have been adapted

While a number of modifications and simplifications have been made, the aim has been to achieve the best possible realism in handling and performance, while maintaining usability within a single-user FS environment. Specifically, the workflow has been changed from a 3-person parallel workflow to one better fitted for the sequential one of a single FS user. Some issues cannot be simulated correctly in FS, others are inadequately documented and, of course, we might have been plain wrong in some cases, in spite of every effort from our side. This version of a Lockheed L-49 Constellation still requires familiarization to be operated successfully within Flight Simulator 9. Those who have flown other versions of the Constellation will find a lot of similarities, but also some differences. Please follow the instructions in the Readme file to install the download in FS. While the aircraft is designed for FS9 and tested in this environment, it is also compatible with FSX with a little editing. Please follow the instructions in the readme file.

Detailed information about the simulation of classic propliners in general can be found in the FSAviator Propliner Tutorial, hosted at the California Classic website by Tom Gibson (http://www.calclassic.com/propliner_tutorial.htm).

The Historical Note gives some background information on the Lockheed Constellation and also lists the different limits on operating weights of the various sub-versions.

The Panel section of the panels will show the location of a gauge. Some systems are described in separate sections, autopilot and fuel system, for example. Please refer to the Operations Section for the actual flight planning and execution.

The Operations Section deals with pre-flight issues and handling the aircraft during the flight itself. Please note that the Constellation requires more detailed user action than some other planes hosted at CalClassic, particularly regarding power planning and manual leaning of mixture. Beyond that, a detailed, step-by-step checklist can be found on the kneeboard. You might find it useful to have a printed version at hand during the flight.

This manual covers only routine flight. In-depth performance data or emergency procedures would be beyond the scope of this text. For those interested in further information, scanned copies of Lockheed L-49 or C-69 aircraft manuals can be purchased for download on the internet. Note that at a given power setting, the L-49 will show identical performance to the L-749, however the L-49's engines have lower performance limits.

Enjoy flying the Lockheed Constellation!

2. Historical Note: The Lockheed Constellation

The introduction of IFR flight rules along controlled airways in 1934 meant a revolution in aviation. The new rules required new aircraft and Douglas was able to dominate this new market with the DC-2 and -3. Competitor Lockheed was offering smaller, high-performance aircraft and Howard Hughes used a Lockheed L-14 Super Electra for a record flight around the world, but in commercial service, the type was less economical than the DC-3 and therefore sold only in small numbers.

As the DC-3 was established as the standard US airliner, aircraft manufacturers began designing a new generation of four-engined airliners. Sponsored by several airlines, the first one was the Douglas DC-4 in 1938, but it turned out to be too expensive, too heavy and too complex, so Douglas had to start all over again. Boeing introduced the B-307 Stratoliner, a passenger version of the B-17 bomber. It was the first pressurized airliner, but only a few were introduced into service before the USA entered WWII.

In 1939, Lockheed was approached by TWA and Howard Hughes to secretly develop a new, advanced aircraft, which eventually would become the L-49 Constellation. It was to be powered with the new R-3350 engine, which then was still under development. The design had an aerodynamically optimized shape for high speed, a long range, a pressurized cabin and hydraulically boosted control surfaces as well as the triple fin that would become the Constellation's trademark. The first batch of aircraft was to be delivered exclusively to TWA, but eventually PAA and KLM were able to secure options of this batch as well.

However, when World War II broke out in Europe in September 1939, development and production of the new aircraft did not have highest priority any more. Eventually, the first flight took place on January 9th, 1943. Pilot was Eddie Allen, on loan from Boeing, because of his great experience with large, multi-engined aircraft. The flight was successful, but there were still many problems to solve, not unexpected for such an advanced aircraft.

One major source of problems was the R-3350 engine, which was still quite immature and suffered from many failures, including engine fires. One such fire eventually killed Eddie Allen when it burned through the main wing spar of a B-29 he was flying. But the rest of the airframe had many other problems as well and production went ahead only very slowly. The similarly advanced B-29 suffered from similar problems, but the new bomber had top priority, while the demand for the L-49 was less urgent once production of the new DC-4/C-54 had started. Furthermore, demand for other Lockheed types, shifting priorities and the difficult production due to the complex shape delayed series production.

Eventually the L-49 entered service with the USAAF early in 1945, designated the C-69. In total, 16 aircraft were delivered to the military. The prototype was eventually fitted with R-2800 engines, but no production version followed this experiment. With the end of World War II, the USAAF sold off the remaining C-69's and did not use this designation again.

But regardless of all the problems that had come up, the Lockheed L-49 was further advanced than any other airliner then available. Practically all airliners were ex-military transport aircraft dating back to before World War II and none were pressurized for fast high-altitude flight. Lockheed bought back tooling as well as delivered and incomplete aircraft and converted the aircraft to true airliner standard, including more advanced fire detection and extinguishing equipment.

TWA and PAA still had the exclusive rights to the first batch and opened service on February 3rd, 1946 to New York - Bermuda (PAA), while TWA followed on February 6th on the New York – Paris route. As expected, it performed far better than any other airliner in service, including the DC-4. Two accidents caused the grounding and modification of the L-49 fleet during the summer of 1946, but the aircraft was back in the air before the competing DC-6 became available. The modification included new fuel injected BA-3 engines with two-speed superchargers instead of the previous single-speed carburetted BA-1, as well as changes to the supercharger drive shaft, the hydraulic system and again a modified fire extinguishing system.

The development of the L-49 Constellation did not stop here. During the production run, the aircraft progressively received strengthening of the airframe to allow higher operating weights. Post war aircraft, designated L-49A, were able to operate with a MTOW of 90,000 instead of 86,250 lbs. Further modification kits were available for even higher operating weights, with designations L-49B to E. While none were converted to B or C standard, roughly half of the aircraft were converted to D or E's. Aircraft so converted can be identified by the presence of external stiffening rails on top of the forward fuselage.

From the 63rd aircraft onwards, the aircraft had steerable nose wheel instead of the previous free-castoring one, and from serial number 2076 onwards the use of the "Speedpak" external cargo pod was possible.

Main US customers of the L-49 were TWA (27 aircraft) and PAA (20), both airlines having used the C-69 in service for the USAAF. Further aircraft were sold to European customers, particularly BOAC (5), KLM (6) and Air France (4). Further aircraft were acquired by American Overseas Airlines (7), LAV (2) and Panagra (2), bringing the total to 73.

Initially, the Constellations were used mainly on high-profile, long-range routes. Competitors were initially forced to use slower, unpressurized airliners, but when it became available, the DC-6 proved to be a capable and reliable alternative.

Invariably, the aircraft were first used on long-range flights to and from New York when introduced into service. The European operators also used the Constellations on services to their colonies in Africa, the Far East and the Caribbean, while TWA was the only operator to serve the continental USA with services between Burbank and La Guardia. The L-49 services were soon augmented with 749s when they became available and were later replaced by Super Constellations. As more advanced types became available, they were gradually replaced on the main lines and served secondary routes instead, replacing older, unpressurized aircraft used previously on such routes.

Many aircraft had their eyebrow windows on the cockpit roof removed during their career and some were eventually fitted with weather radar when it became mandatory for transport aircraft in the early '60s. A steerable nosewheel was retrofitted to many aircraft. TWA had at least some aircraft converted to allow prop reversing.

With the introduction of the long range L-749, its outboard fuel tanks were also retrofitted to a more than a dozen aircraft, which were designated L-149, but none were built as such.

For comparison, here are the main differences between individual L-49 versions:

	MTOW (lbs)	MLW (lbs)	
C-69	86'250	75'000	see note
L- 49	86'250	75'000	
L- 49A	90'000	77'800	
L- 49B	93'000	77'800	none converted
L- 49C	93'000	83'000	none converted
L- 49D	96'000	83'000	34 converted
L- 49E	98'000	84'500	7 converted
L-149	100'000	83'000	14 converted

Note: C-69 with MTOW of 82,000-86',50 lbs and MLW 67,000-75',000 lbs, increasing during production run.

The L-49 was developed further into the next generation, the L-649 and -749 airliner, which used both newly available technology such as more powerful engines, as well as experiences with the L-49. Lockheed claimed them to be 50% new development, even though the external difference is minimal. From this time on, the L-49 was frequently called L-049, but both designations refer to the same aircraft. The L-49 prototype was later used to develop the stretched L-1049 Super Constellation.

However, by 1955, most original operators had sold their L-49s, only TWA was using them until 1961 and Panair do Brasil retained 2 until the following year. The aircraft remained in service with second-tier operators, but hardly any L-49 remained in use when the airlines began replacing their propliners with jets. The L-49's were the first to go, only 1 of 88 remaining active in 1968, out of a total of about 250 Connies still flying by then. Those Connies continuing in commercial service were mostly the far more capable and reliable 749A's and 1049G/H's. The L-49's typicaly were in storage by the early 60's and scrapped by the end of the decade.

Today, 4 L-49 aircraft still exist, one of them originally a C-69. None of them is airworthy.

Sources:
Marson, P. J.: The Lockheed Constellation. Air Britain, 2007
Wilson, S.: Lockheed Constellation. Aviation Notebook Series. Notebook Publications, 2001

3. Panel Overview

The Main Panel

1. Airspeed indicator
2. Attitude indicator
3. Altitude indicator
4. Turn and bank indicator
5. Directional gyro
6. Vertical speed indicator
7. Localizer light
8. Clock
9. RMI
10. VOR/ILS
11. OMI marker lights
12. Radio altitude
13. RMI source selector switches
14. Pitot tube selector switches
15. VOR bearing selector
16. Vacuum warning light
17. Hydraulics warning light
18. Registration number
19. Parking brake
20. Magnetic compass
21. Light switches
22. Master fire warning light
23. MAP gauges (2x)
24. RPM gauges (2x)
25. Autopilot
26. Landing gear lever
27. Trim indicator
28. Flap and gear indicator
29. Outside air temperature
30. Sim Icons (hidden)

Radio Stack and Navigation instruments
Click on radio stack simicon to display the radio stack, with radio boxes reproducing typical vintage instruments. Typically, The L-49 was equipped with VHF radios and two ADF. For convenience of FS9 virtual airlines pilots, a transponder has been added. DME is also fitted, even though this technology was introduced only several years after the L-49 Constellation left main line service and would not have been available for its pilots during the initial years of

service. It can be easily removed by adding double slashes at the beginning of the corresponding line in the panel.cfg file.
<u>VOR/ILS:</u> The VOR/ILS gauge is slaved to VOR1 receiver. The bearing selector is located
below it.
<u>RMI:</u> The two needle RMI can indicate both VOR and ADF bearings. The selector switches are located on the main panel below the primary flight instruments in 2D panel view and on the center pedestal in VC view. Tooltips show DME distances to both transmitters. 2 RMI indicators are fitted on the pop-up radio panel in 2D panel view.
<u>ADF receivers:</u> The ADFs are switched on by default on loading the airplane. In the image you can see the function of every radio stack mouse click spot in the radio stack pop up.

In VC view, the radio stack is located in the central pedestal console. The radio receivers have the same functions available as the radio stack pop up.
<u>ATC (Transponder):</u> The transponder code identifies your plane on the radar screens of the air traffic control. If the VFR button is pushed, 1200 is used as transponder code, and no other code can be dialed in as long as this button is active. The TST button is used to check the displays of the ATC Radio. Like DME, transponders would not have been in use whilst the L-49 was in main line service. It is added here since it is required for some FS ATC applications.
<u>Automatic Approach Warning Lights</u>: The left lamp illuminates if no VOR signal is received, and the right lamp is on if no glideslope is available. The Approach

Warning Lights will not work if the NAV1 Radio is turned off, or if no localizer signal is received.
DME: When receiving a VOR/DME signal, the distance to the station is displayed in nautical miles. Use the knob to select either N1 (NAV1) or N2 (NAV2). The MKR button toggles the OMI marker sound. The DME is not activated by default.
Audio selector panel: toggles sound for COMM, ADF, NAV and Marker receivers.
Radio altimeter: The radio altimeter is reproducing the early APN1 model. Two ranges are available, one for 0 – 400 ft altitude and the other 0 – 4000 ft altitude. The right bottom knob toggles between the two ranges. The left bottom knob is adjusting decision height. The altitude alert lights and the altitude limit switch are not included here.

Icon Block
The SimIcon block consists of 12 icons and appears when the mouse pointer hovers over it. on the left side, radio stack, checklist, ATC, map and GPS are FS default. A right-click on the checklist icon will open the status gauge. The remaining icons are:
Cowl Flaps: The left hand icon tooltip of the icon will close all cowl flaps one step; clicking the right hand icon tooltip will open them.
Pitch Set: Enables adjusting of prop pitch without switching to the Flight Engineer's Panel. The left hand icon tooltip of the icon will decrease propeller RPM; clicking the right hand icon tooltip will increase it. All four propellers are affected and each click corresponds to a 2% change. Propellers cannot be feathered or unfeathered using this icon, instead, use the Propeller Levers on the Flight Engineer's Panel.
Supercharger and Mixture set best: This will set superchargers to an appropriate setting for the curent altitude and mixture to Auto Rich.
Throttle Quadrant:
FE panel: Opens the FE panel.
Mixture: There are two manual mixture setting icons, labelled **AL** and **10%**, to help in adjusting mixture in manual leaning procedure.
The **AL** icon sets the mixture to the Auto Lean setting Fuel/Air Ratio (FAR) of 0.072 in FS9 and the **10%** icon sets the mixture to the 10% BMEP drop manual lean setting (FAR of 0.064 in FS9), avoiding the need to spend time working manually with mixture levers to get the desired leaning.
The manual leaning procedure, using these icons, is as follows:

1.- Drag the mixture levers to the manual range (below 38%).
2.- Left click on the desired mixture icon.

As these icons are just a virtual pilot help (there is no FE here) in leaning procedures, all other instructions for manual leaning are applicable. In particular, remember to adjust mixture again each time you change more than 1000 ft of altitude.

The original Auto Rich and Auto Lean mixture levers ranges are not modified and should be used as directed.

Autopilot (AP): – modified version to be added --
The Autopilot unit is modified from the default DC-3 system. Keep in mind that the AP will only hold attitude and heading. It is not able to capture or follow navaid tracks. For the convenience of the user, a 'hold altitude' function is added, which can be activated by clicking on the green light on the top left side of the attitude unit.

The AP unit can be switched on at the lower left side. The knobs below the gyro and attitude display will adjust the reference setting. The knobs on the top of the displays will initiate a turn or change in altitude.

The heading reference knob on the top right corner should be used to set the aircraft's current heading before switching on the autopilot. Switching it on without doing so first can result in unpleasant heading changes.

When loading the Constellation after a flight in another aircraft, be aware that FS might try to use autopilot modes available in other aircraft, like NAV or GPS, if they have been used before. Switch off the AP before changing planes.

Throttle Quadrant –update speeds --
On the left is the elevator trim indicator, clicking on the 'TO' label will set trim to take-off setting. Right of the four throttles are propeller control and flap lever.

Status Gauge
The Status Gauge can be opened by a right-click on the checklist icon and shows a comprehensive table of aircraft functions. While this was not available to Constellation aircrew in real life, it was found to be very valuable for testing and troubleshooting. A FE would be able to produce most of the information at the pilot's request anyway. The engine horsepower readout uses the following color codes:

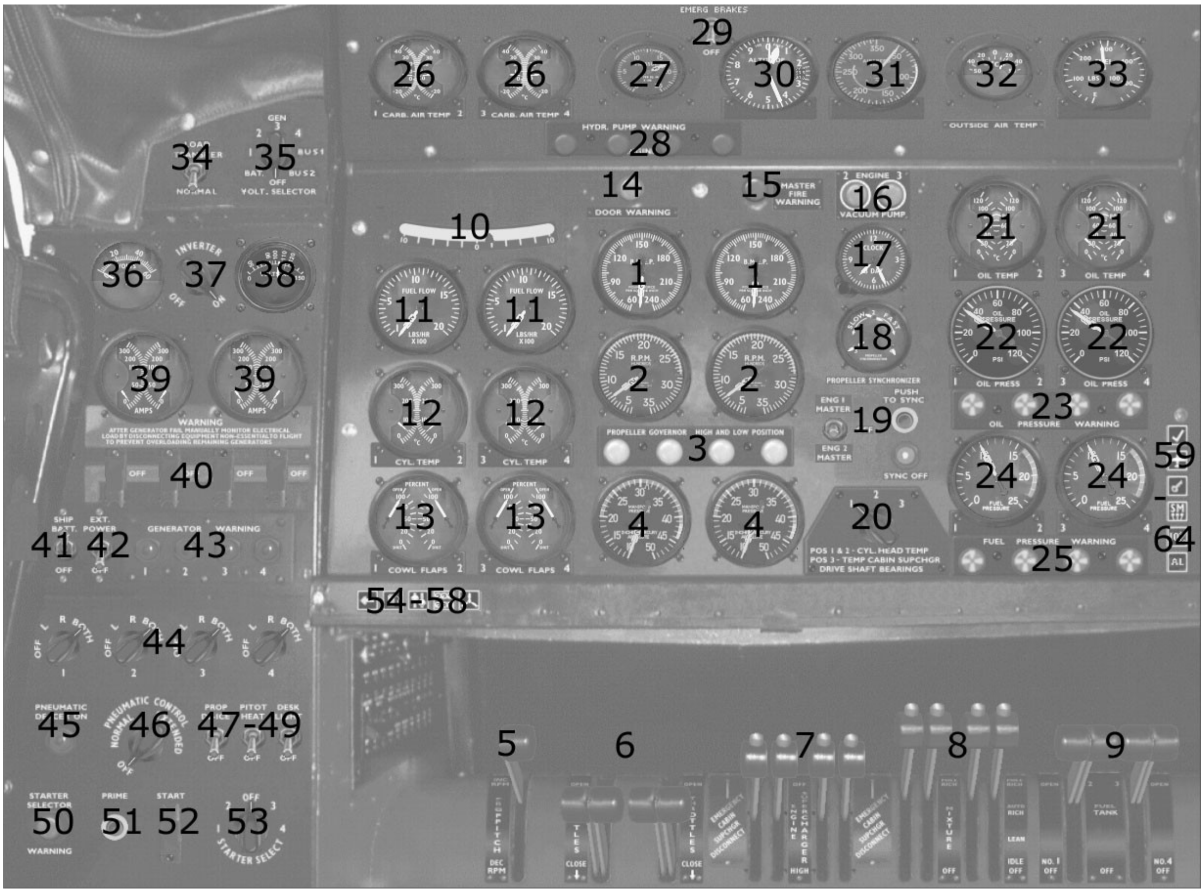
White - OK, no danger of engine failure;

yellow - the current power setting will cause damage if left too long in this configuration (even after throttling back or adjusting RPM it will remain yellow until the internal engine failure counter is back to zero, which may take a couple of minutes);

red - immediate action required – reduce throttle and prop pitch.

Miscellaneous
<u>Airspeed indicator:</u> A left-click on the gauge face will display a digital IAS readout, another click will hide it again.
<u>Vacuum system Warning lights:</u> Vacuum pump driven instruments (such as Directional Gyro or the Attitude Indicator) will not work properly if these lights are indicating low suction press.
<u>Hydraulic Pressure Warning Light:</u> Indicates low hydraulic pressure. The Connie has two hydraulic pressure circuits (1500 psi each) for flight control boosters, gear and wing flap operation.
<u>Three-Axis Trim Indicator:</u> Click into the gauge for rudder trim, aileron trim and elevator (pitch) trim. Pitch trim can be zeroed by clicking into the green display.

FE Panel



1. BMEP
2. RPM
3. High/low prop position warning lights
4. MAP
5. Master RPM Lever
6. Throttles
7. Supercharger switches
8. Mixture levers
9. Tank selectors
10. Deck angle indicator
11. Fuel flow
12. CHT
13. Cowl flap position
14. Door warning light / switch
15. Master Fire warning
16. Vacuum pump warning
17. Clock
18. Synchroscope
19. Synchronizer switch
20. CHT temp. selector switch
21. Oil temperature
22. Oil pressure
23. Oil pressure warning lights
24. Fuel pressure
25. Fuel pressure warning lights
26. Air intake temperature
27. Hydraulic pressure
28. Hydr. press. warning lights
29. Emergency brake switch
30. Altimeter
31. Airspeed indicator
32. OAT
33. Fuel totalizer
34. Load transfer switch
35. Voltmeter selector
36. Main bus voltmeter
37. Inverter switch
38. Avionics bus voltmeter
39. Amperemeter
40. Generator switches (covered)
41. Battery switch
42. Ground power switch
43. Generator warning lights
44. Magneto switches
45. Wing de-icer warning light
46. Wing de-icing control
47. Prop de-ice switch
48. Pitot heat switch
49. Panel light switch
50. Engine Start Ignition warning
51. Prime button
52. Start switch (covered)
53. Engine start selector
54. Back to Main Panel
55. Fuel System
56. Fuel dump and Emergency Cut-off
57. Fuel gauges
58. Prop Control
59. Checklist / Status Gauge
60. Toggle Views
61. Engine Auto Start
62. Mixture/Supercharger best
63. Mixture 10% lean
64. Mixture AutoLean

The highly sophisticated engines of the Constellation require a dedicated Flight engineer to take care of them. Part of the real-life complexity cannot be simulated within Flight simulator or has to be simplified to keep pilot workload in reasonable limits during critical phases of the flight.

For a detailed list of the instruments see the illustration below. Engine instruments are typically installed as a pair of gauges with dual needles each. The main gauges are in the center of the Flight Engineer's (FE) panel: Manifold Pressure, Engine RPM and Engine Torque (BMEP).

The MAP and RPM gauges are marked with a red line showing the power limit for take-off power. The border between yellow and green arc shows the maximum continuous setting (METO). The Fuel Flow Indicator shows engine fuel consumption in pounds per hour.

At high altitude, the supercharger drive can be switched to high RPM using the Supercharger Control switches – for details, refer to the "Blower Shift" procedure in the Operations Section. The outboard switches have a 'disconnect' position – this would disconnect the cabin supercharger from the engines, but it has no effect on the sim. The engine superchargers cannot be disconnected.

For increased realism, a small "blue bug" is visible on the left MAP gauge of the main and FE panel. While the flight model performance is considerably close to real-life, you should not increase MAP to values higher than the blue bug. FS does not display the MAP values of the R-3350's two-stage geared supercharger correctly and the bug indicates the point where the throttles would be fully open in the real aircraft. Without going into technical detail, the supercharger is geared to the crankshaft of the R-3350, unlike a turbocharger. The MAP available therefore depends on engine RPM, a detail that FS does not simulate.

The synchronizing system can be activated on the main FE panel, the synchroscope shows three spinners (for engines 2, 3 and 4) comparing its propeller rpm to engine 1: The spinner is rotating clockwise if propeller rotation is faster than the propeller of engine 1, and anti-clockwise if it is slower. The Master Engine can be switched between engine 1 and 2.

Pneumatic wing and tail surface de-icing, pitot heat and prop de-ice is controlled by switches from the left side of the FE panel.

Prop Control panel

While individual throttles are available, RPM is controlled by a single Master RPM Lever – both on the pilot's panel and on the FE panel. Switches on the Propeller Control Panel allow changes to individual engines.

Propeller Feathering Switches are on the Propeller Control subpanel as well. To feather a prop, set engine throttle lever to idle, turn off the electrical fuel pump, shut down engine by moving the mixture lever to position CUT OFF, set ignition switch to position OFF and move propeller switch to position FEATHER. Propeller should stop spinning within a few seconds.

The Propeller Control subpanel also has switches for each engine's cowl flaps and engine air intake heat.

All cowl flaps can also be set identically using the simicon on the pilot’s panel. The cowl flaps are less efficient in the L-49 than in the later versions, but can be fully opened during flight.

CHT temperature can be displayed either for the front or rear row of the engines using the selector switch above the supercharger control levers. Overheating of the supercharger drive shaft bearings is not simulated - one source of engine fire you don’t have to worry about in FS. Engine air intake heat will use hot air from within the cowling to avoid ice accumulation in the air intake, similar to carburettor heating.

Next to the feather buttons are the switches for the auxiliary fuel pumps. You will need them for starting the engines and they should be on as a precautionary measure during take-off and landing.

Electrical System

The electrical system is controlled from the left side of the FE panel. The main Inverter Switch controls AC power supply for radios and other instruments, AC power can be read from the right voltmeter.

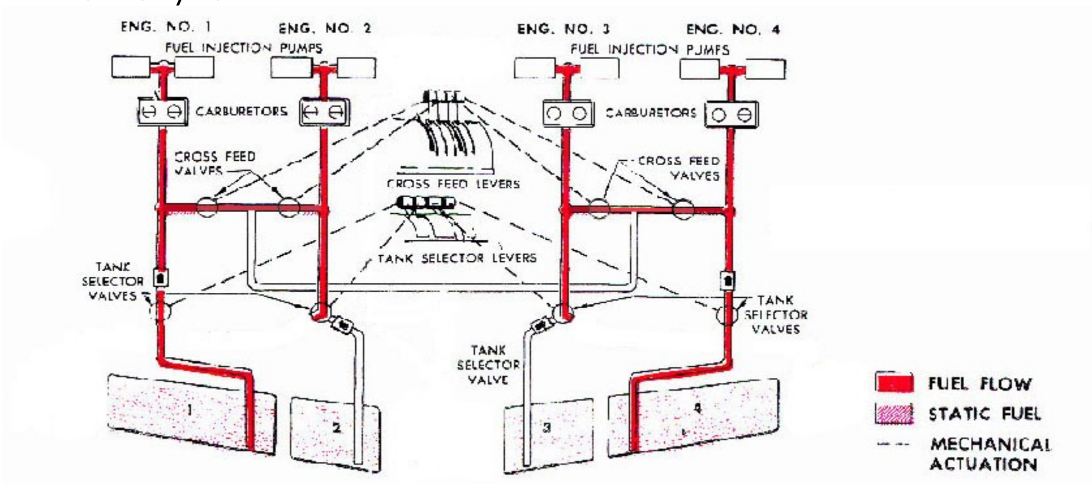
Each engine drives a generator. Click to open the protection cover. Then, each click toggles the switch ON/OFF. The cover closes automatically, but only with generator toggled on. Check main bus voltmeter and amperemeter for electrical power. On-board batteries are available, but have only limited power. They might only last for a couple of engine start attempts. The Ground power switch allows the simulation of an external starter cart which provides 25.5V DC to the aircraft as long as the parking brake is set. The battery can be charged by turning on the battery switch and activating ground power. With the battery switch ON, but neither generators nor external power turned on, battery is depleting and the main bus delivers the battery voltage. Electrics will fail if battery voltage has dropped under 17 volts.

The Ignition Switches are located on the pilot's overhead panel in real life, but have been relocated to the FE panel to make engine starts more practicable. The Engine Start Selector selects the engine to be affected when using the Primer or the Starter switches. Also, the Engine Start Ignition Light always refers to the engine selected and indicates that the Ignition Switch of the engine selected is in a proper position. When engaging the Starter, hold it until the light goes out, signaling that the engine is running.

The Primer switch is used during engine start. Each push gives a shot of primer. Use of the primer depends on whether an engine is cold or hot. The Engine Starter invokes the starter of the engine selected. For a successful engine start, following the checklist is strongly recommended, otherwise the engine start cheat button will become your best friend. Refer to the Operations Section for engine start sequence.

Tank system layout

The fuel system of the L-49 is considerably simpler than in later versions. A total of 4 tanks are installed, one behind each engine in the inner wing section, numbered 1 to 4 from port to starboard, like the corresponding engines. Note that tanks 2 and 3 are depicted smaller than tanks 1 and 4 – they have less capacity since the main gear wheel wells run through them. The tank valves can be opened and closed by 4 levers on the right side of the Flight Engineer’s main panel. All tanks are connected to a crossfeed system that allows feeding any engine from any tank.



The diagram above shows the inboard engines draining fuel from the respective outboard tanks via the crossfeed system.

Flight Simulator 9 uses its own naming system for the tanks (see the following table).

The total fuel capacity is, from port to starboard:

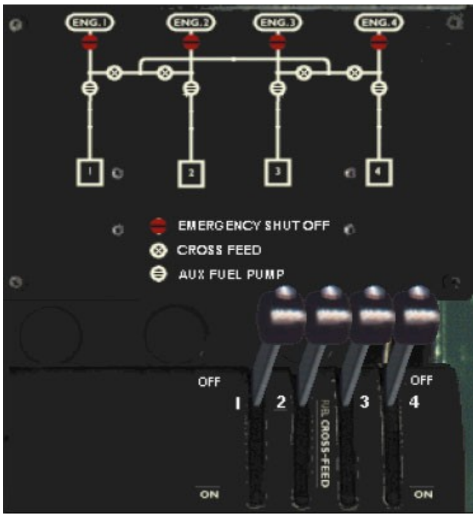
Tank 1	1555 gallons	9330 lbs	FS: External1
Tank 2	790 gallons	4740 lbs	FS: Center2
Tank 3	790 gallons	4740 lbs	FS: Center3
Tank 4	1555 gallons	9330 lbs	FS: External2
Total	**4690 gallons**	**28140 lbs**	

A fuel tank totalizer gauge is placed on the FE panel indicating the total content of the fuel tanks. The content of the individual tanks can be read from the fuel tank subpanel available by clicking the fuel panel SimIcon. The Fuel Tank Warning Lights correspond to the fuel tank indicators. These lights are on if a tank contains less than 10% of its total capacity.

Fuel flow from the tanks to the engines is managed in two locations. The fuel tank selector levers are at the right hand side of the FE panel. The levers have two positions, open and closed. This allows relatively simple "tank to engine" fuel supply.

However, for long range flights or when an engine is inoperative, you will need to crossfeed fuel. There are switches hidden on the auxiliary control stand that can be opened by clicking on the Fuel System SimIcon at the left, above the RPM lever. It opens the subpanel. To allow an engine to feed from the crossfeed system, you will need to open at least 2 crossfeed valves – the one for the supplied engine and the one to the tank system where the fuel comes from. For example, if you want to run engine 2 with fuel from tank 1, you'll have to open both crossfeed levers 1 and 2, and tank selector lever 2 will have to be closed to avoid engine 2 still feeding from tank 2. Each engine will always drain fuel from the nearest tank when several tanks are available.

Fuel is loaded in all tanks equally until 2 and 3 are filled up and the remaining fuel is split between tanks 1 and 4. During flight, once climb is established, you run the inboard engines from tanks 1 and 4 using crossfeed until all tanks have the same volume. For the rest of the flight, all engines would be run in a tank-to engine configuration.



The picture on the left shows the auxiliary control stand on the Fuel System subpanel.

On the bottom are the crossfeed levers for engines 1 to 4. Moving the lever down to the 'ON' position will open the fuel line to the crossfeed system, either to feed or to receive fuel. The diagram above them shows the layout of the fuel system.

As mentioned above, the fuel tank switches are located on the main FE panel and the fuel pump switches on the Lower FE subpanel.

Fuel dump and Emergency Cut-off Switches

This subpanel has four emergency cut-off levers to quickly shut down an engine in case of a severe malfunction.

Between them are two emergency fuel dump levers. Moving either of the two red handles on the 2D subpanel downwards to the first stop has no effect on the fuel dump system. In real life, this position would extend the dump chutes at the wing roots. Moving the left handle further down starts the dumping process from portside tanks 1 and 2, while the right handle will dump fuel from the starboard side. Each handle will also start the visible fuel flow effect in spot view. While fuel from each side can be dumped separately, the fuel flow effect will show a trail from both dump ports due to the way the effect is handled. If you can see the visible trail but the tank gauges don't show any dump then try cycling through the views. Fuel dump rates are 85 gallons per minute for each tank. Some minimum fuel is conserved by standpipes, 30 gallons for tanks 1 and 4 and 70 gallons for tanks 2 and 3.The aircraft's weight will reduce from MTOW to MLW in about 8 minutes (L-49E values), and tanks 1 and 4 will go from full to empty (except for a minimum protected by standpipes) in about 15 minutes, while the other tanks empty in about 5 minutes.

Avoid asymmetric fuel loads of more than a few hundred pounds. While it won’t cause structural damage, it will still cause considerable yaw.

Dumping can be stopped and restarted as required. To stop the fuel dump, the real-life FE would first move the dump levers to the “closed” position and then return it to the intermediate position for 15 or 30 seconds, extending the dump chutes again and allowing the pipes to drain before finally moving the levers to the closed position. In FS, you do not have to worry about draining fuel into the fuselage, right next to the cabin heater, and moving the levers from open to either the intermediate or closed position will stop the fuel dump. You may still simulate the real-life procedure. The fuel dump effect will still be visible in red line position for about 5 seconds as long as chute pipes are drained.

In VC view, the handles can be moved as well by up/down mouse movements.

VC

In VC view, the main panel is identical to the 2d panel for all practical purposes.

Pressing Shift then E then 2 will open the crew door right next to the FE station. This animation is only visible in the VC, so in the external view the crew door will remain closed. Clicking on the windscreen will deploy the sunshades.

View Settings

Various pre-set views are available in both 2D and VC, and, in VC only, a variable view forward (the default view) with the hatswitch allowing a 360 degree direction/elevation look around. The default view forward is set to optimize the VC panel view.

Always ensure NumLock is on before using the following options.

Views which require just "numberpad xx" are maintained as long as the key is held down but can also then be locked with Ctrl+Shift, releasing Ctrl slightly before Shift. To reset, press the spacebar or the numberpad key again.

For views which require "Ctrl+Shift then numberpad xx", hold down Ctrl+Shift then numberpad key. They can be locked in position by releasing Ctrl slightly before Shift and reset to forward view with the numberpad key.

Pilot's view forward left	Numberpad 7
Pilot's view left	Numberpad 4
Pilot's left wing view	Numberpad 1
Pilot's view forward right	Numberpad 9
Pilot's view right	Numberpad 6
Co-pilot's right wing view	Numberpad 3
Pilot's view rear	Numberpad 5
Pilot's pedestal view	Numberpad 2

Pilot's view of FE panel	Ctrl-Shift-3
Flight Engineer's view forward	Ctrl-Shift-5
Overhead Panel View	Ctrl-Shift-8
Passenger's view from right rear	Ctrl-Shift-9
Passenger's view from right mid	Ctrl-Shift-6 (needs key reassignment)
Passenger's view from left front	Ctrl-Shift-1
Passenger's view from left mid	Ctrl-Shift-4 (needs key reassignment)
Passenger's view from left rear	Ctrl-Shift-7
Astrodome view	Ctrl-Shift-2

To have two passenger views from mid left and mid right available, it will be necessary to create keyboard assignments. Go to options/controls/-assignments, find the commands "look left/up" and "look up/right" and assign preferred keys.

In VC mode, the eyepoint for all of these views when locked (and the default view) can also be moved around to a limited extent by using the keyboard. It then affects all views.

Ctrl held down then Backspace/Enter (++) - forward/back

Ctrl+Shift held down then Backspace/Enter (++) - left/right

Shift held down then Backspace/Enter (++) - up/down

Spacebar to return to default view.

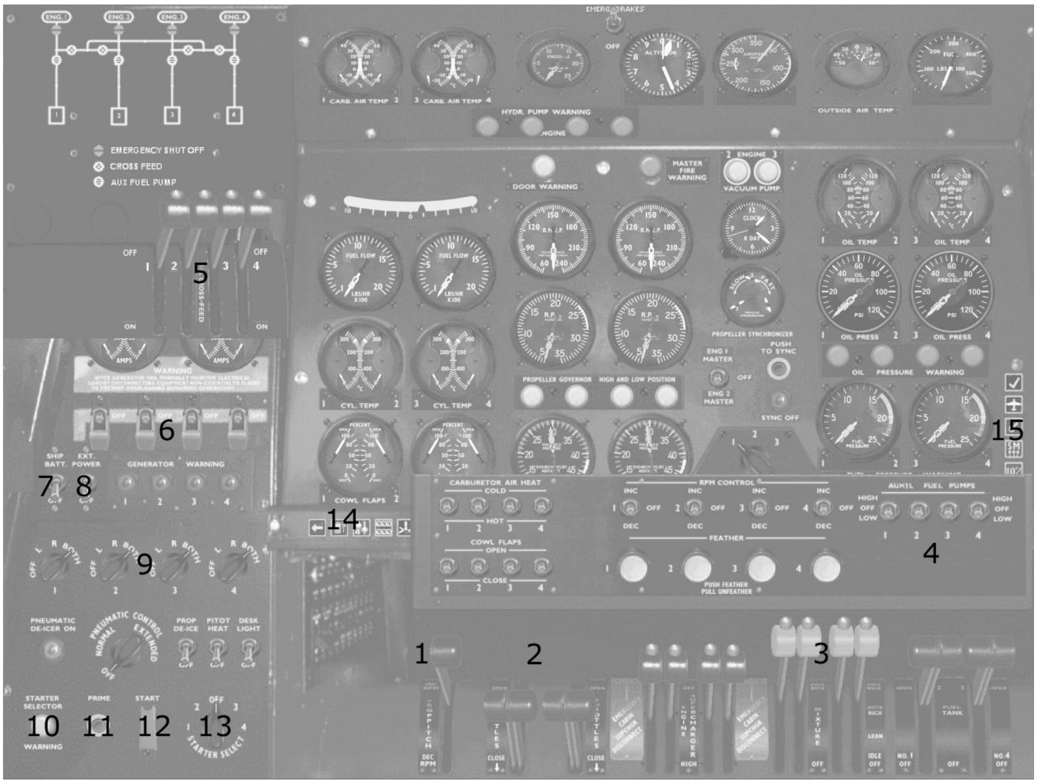
When the view forward default eyepoint in the VC is moved this way, a 360 degree look around is still possible from this new eyepoint using the hat switch.

4. Operation of the Lockheed L-49

Engine Start

There are three ways to bring the R-3350s to life on your new Constellation. They are described here in order of three options: easy, more complex and finally as close to realistic procedure as we can model it and find practical in the FS environment. With the second and third options you also get the "Start XX" calls.

So call for the fire guard and prepare for ignition. Here is what you see when you open the FE panel.



<u>Option 1:</u> When you just want to get the bird in the air and don't have a lot of time for fiddling with knobs and levers…just 2 clicks will have your dedicated virtual FE start everything up for you.

1. Switch on the Master Battery (7) to make sure you have juice on the circuits.
2. Click on the "Engine Auto Start" SimIcon (15) on the right side of the FE panel.

Note that in this option the start sequence is the FS standard left to right order and not the correct sequence used by real Connie crews, just as using CTRL+E. But this is the way FS does it and can't be changed.

<u>Option 2:</u> You need a little more time but part of the fun of starting a radial-engined airplane is watching the action from the outside. So you prepare a few things at the FE panel and then step outside and watch the show as you fire up the big power plants.

1. If you have not done so already set the parking brake to enable the ground power cart.
2. Switch on the selector for External Power (8) and the Master Battery (7).

3. Click on the Lower FE Panel icon (14) to open the subpanel with the fuel pumps.
4. Set pumps 1, 2, 3 and 4 (4) to HIGH to ensure you have enough fuel pressure to feed the engines. Then you can close this window.
5. Set all 4 Magneto Selector switches (9) on the main FE panel to BOTH.
6. Move all 4 throttle levers (2) to about 7-8%, check this by hovering the mouse over the levers.
7. Move all 4 mixture levers (3) to FULL RICH (tooltip 100%).
8. Now switch to the external view. 8. Tip: If you open the FE panel window whilst in 2D, you will be able to get a quick pilot's view of the left or right wing and engines by using either numberpad #1 or #3 or the hatswitch and without closing the FE window.
9. Press E and then the 3 key to select the #3 engine.
10. Press M and then repeatedly the + key to until the engine has started spewing flames and smoke.
11. Repeat steps 9 & 10 for engines #4, #2 and finally #1.
12. Return inside to the FE panel to switch off the EXTERNAL POWER and continue with the rest of the "After Starting" checklist.

<u>Option 3:</u> Now we're doing the whole process from the FE panel and its subpanels. Before getting into this it may be worth while checking out one of the many nice features included in the simulation of the Connie. The tool tips on the Starter switch can actually walk you through the engine start process by telling you what is missing from a successful start of the selected engine by hovering the mouse over it. You may want to open the Fuel Sub Panel and move it a little up similar to the screeenshot so that all required elements are visible without a lot of switching.

Starter Switch

Throttles @ less than 7%

MAGs set OFF

Fuel Pumps OFF

Mixtures not set (occasionally less than Full Rich is needed)

A shot of Primer is needed to start

As usual the parking brake needs to be set before engine start.
1. Switch on the selector for External Power (8) ….we'll turn on the Master Battery (7) later.
2. Check all Magneto Selectors (9) are in the OFF position.

3. Check all Throttles (2) are in the CLOSED position.
4. Check all Mixture levers (3) are in the CUT OFF position.
5. Set Starter Selector (13) to #3.
6. To clear the engine of oil which may have collected in the bottom cylinders we will now bump the starter Starter Switch (12) 2-3 times with a short pause after each bump.
7. Set throttle for about 800-1000 rpm idle speed (7-8% on the tool tip)
8. Set Mixture to FULL RICH (certain conditions require less than this so verify via tool tip on the starter switch).
9. Set fuel pumps (5) first to LOW (check pressure on gauge) then HIGH for starting.
10. Set Magneto Selector (9) for engine 3 to BOTH. Normally this would be done by the Captain/FO on the overhead.
11. Push the primer button (11) once and check the starter button tool tip if another shot is required.
12. Engage the starter button (12) until the engine fires up but no more than 30 seconds.
13. When the engine is running stable switch Generator (6) to ON. The light should go out and the cover closes.
14. Repeat steps 5 to 13 for engine #4
Now switch on the Master Battery (5) and turn OFF the External Power connection (6)
15. Repeat steps 5 to 13 for engines #2 and #1.

Take-off and Climb

Detailed instructions are available in the checklist. Once airborne, you retract the gear and accelerate to 120 kts first in a shallow climb at take-off power, before you can reduce power to METO (maximum continuous) power. You will want to limit time in take-off power as it is very hard on the engine, and a maximum of 2 minutes is allowed. METO power is simple to set – first reduce MAP to the end of the green arc on the gauge face (43.5”) and then reduce RPM to the end of the green arc as well (2400 RPM). This is followed by a steeper climb at METO power and take-off flaps (60%) above all obstructions.

Alternatively, at lighter weights (below 86,000 lbs MTOW), the first power reduction can be made to 40” MAP at the same 2400 RPM. This setting was also used in real life, most likely to reduce engine strain, but performance will be only marginal at the heavy operating weights of the L-49E simulated here.

Only after clearing the ground obstructions, you allow the aircraft to accelerate to 130 kts, retract flaps, accelerate further to 150 kts and establish climb power. Set MAP and RPM first, then you can set the autopilot and change to the FE panel to set details like cowl flap settings. Climb power is monitored by checking engine torque, indicated by the BMEP gauges (literally ’brake mean effective pressure’). As power settings were typically monitored by the FE rather than the pilot, the BMEP gauges are located on the FE panel, but you have access to the BMEP values by opening the status gauge (right-click on the checklist icon).

Climb power typically is 2300 RPM and 144 BMEP which will give you about 1400 hp per engine. During climb, you will need to maintain constant power – increase throttle to keep BMEP at 144.

Don’t let the airspeed drop below 150 kts – it will be hard to accelerate back and you probably have to level off. Once climb is established, you can change to the FE panel to set details like cowl flap settings.

At around 14,000 ft, you will notice that the MAP is at the full throttle position (blue bug) and from there on, MAP and power is dropping as you climb. This is the "critical altitude" for climb power. For METO power, critical altitude is around 5,000 ft.

As the air is getting thinner, the supercharger drive gear should be be shifted to higher RPM, just like the gear in a car with a manual gearbox. At around 14,000 ft, you need to change the superchargers to higher drive speed, the "blower shift". Briefly level off, reduce RPM to avoid straining the engine and shift superchargers to "high". The engine is less efficient in high blower, you will need to adjust throttle again to maintain climb power. For METO climb power, you will need to shift around 9,000 ft, METO power in High Blower (HB) is 2400 rpm and 177 BMEP for 1800 hp. In real life the shift was usually done with no more than 2 engines at a time and keeping the #1 and #4 engine shifts separate so as to maintain cabin pressure.

Be sure you are climbing in Auto Rich mixture, as indicated in the check list.

Climb and descent rate is legally required to be at least 500 fpm. Initial rate of climb can be as high as 1000 fpm, though, particularly at lower weights. If you cannot maintain 500 fpm within controlled airspace, you need to level off and begin the cruise segment.

Cruise power settings

There is no 'one size fits all' solution for cruise power for an aircraft of this size and weight. While take-off and climb are relatively straightforward, choosing the right cruise power setting is determined by a number of factors. The plane was designed with long-range operation in mind, hence the weight of the plane varies considerably as fuel is burnt off – at a rate of about one ton per hour.

A number of basic power settings are given in the checklist. For short flights this might be just fine. On short-range flights, flight segments are usually divided into 1/3 for climb, cruise and descent each. Even at high load, cruise at FL 140 to 160 is usually possible. If we (conservatively) estimate climb rate at 500 fpm average, we need about 30 minutes to reach our operational ceiling. That means that the 'short flight rule' would apply to any flight up to 1½ hours. There is no particular need to use elaborate fuel and power planning for flights of such a short duration or only slightly longer.

For longer flights, more care must be taken for flight planning. While we have a large number of options, these are not random. The basic principles are described in the FSAviator Propliner Tutorial mentioned above. In brief, we do not want to let airspeed (and drag) rise, but we either want to climb high into thin air with lower drag, where we get more true air speed (TAS) for the same indicated air speed (IAS) or reduce power to get the same IAS for less fuel consumption and engine strain. Significant headwind needs to be countered by higher cruise power settings and possibly lower cruise levels, but don't cruise nose down unless you're battling a severe headwind. Normally your HSI should show slightly pitch up, more so at long range cruise speeds.

Once you have chosen a route and calculated the total distance, you will need to calculate fuel requirements. As weight, and maybe power setting, is changing along the flight, for best precision you must split a long flight into several segments to calculate total trip fuel consumed. For longer ranges, you will need to consider step climbing as well.

During the flight, you will need to check fuel and compare it to the flight plan. You may calculate it using the fuel gauges or look it up, either in the aircraft menu or in the Status Gauge. Checking every hour is a realistic figure and was done so in real life.

As the flight continues and fuel is burnt off, you will need to adapt power. You can reduce power to maintain IAS, but you can also check whether cruise at a higher flight level will be possible. If the pitch trim indicator shows a zero or nose down trim, flight at a higher level is usually possible.

Flight planning is no guesswork, but you need to check the supplied performance data.

The Cruise Power Table

The Cruise Power Table allows you to calculate performance and fuel consumption for flight planning. The documentation includes a table of high, medium and low power settings for different weights. Figures are given in intervals of 10,000 lbs and various altitudes.

For a given weight, power settings, resulting airspeed and fuel consumption are looked up and time and distance to the next weight bracket in the performance section can be calculated. Then the process is repeated again until we have covered the distance to our destination.

Cruise power is defined by RPM (engine revolutions per minute) and BMEP. You cannot set BMEP directly, but you can control BMEP by adjusting throttle or RPM. Unlike the pilot, the Flight Engineer can read BMEP values from his gauges on the FE panel.

In the cruise tables you also have an indication of "specific range" (the distance flown in nm with 100 lb of fuel), which is very useful to calculate range or fuel consumed. You can see that specific range is very constant across all altitudes in normal cruise power setting, but is increasing a lot as weight is decreasing. This means that using this normal cruise power and speeds, cruise altitude is not a concern for range, you can choose altitude depending on winds aloft, terrain obstructions, etc., but altitude is still a factor in flight time: the higher you fly, the lower is the flight duration.

Cruise is flown in lean mixture, as fuel efficiency is a clear concern in long range flights. Cruise tables are made for a lean mixture obtained leaning to drop BMEP 10% below the best power mixture setting (see manual leaning procedures below).

For aircraft fitted with the Speedpak, because of increased drag, you may decrease cruising speeds by 10 kts TAS compared to the power table, and decrease climb rate by 35 fpm. The empty Speedpak weighs 1,800 lbs – you may add this extra weight as cargo.

Fuel planning

How much fuel do we need? Fuel load is usually determined by going through the following list:

1. Engine start, taxi, runup: 20 lbs/min, 30 minutes is sufficient: **600 lbs**
2. Take-off **200 lbs**
3. Climb power: 750 lbs per engine and hour, 3000 lbs/h. Climb rate depends on weight, the performance section gives the data. 700 – 500 fpm are usually possible, you can calculate 500 fpm if you want to be cautious. Forward airspeed is 150 kts.
4. Cruise power: Cruise fuel requirements can be taken from the power table, as explained above. Remember that fuel flow rates are pounds/hr per single engine. Convert IAS to TAS at cruise level and consider wind – these are still-air

values. For longer flights, you may calculate 2 or 3 intermediate weights to calculate performance at lower weights.
5. 15% Headwind reserves of cruise fuel. More might be required for long overwater missions.
6. 45 minutes of holding reserves **1000 lbs**
Calculating descent fuel makes relatively little difference – use cruise fuel and you have fuel for ground handling after landing as well.

Mach Limit
Since the Constellation does not have a Machmeter, the FAA restricts airspeed at high altitudes, slightly different for cruise and descent. This should be hardly a problem unless cruising at very high power levels at low weights.

For cruise: 236 knots for sea level to 16000 ft. Above 16000 ft reduce speed 4 knots for each additional 1000 ft of altitude.

For descent: 261 knots for sea level to 17000 ft. Above 17000 ft reduce speed 5 knots for each additional 1000 ft of altitude.

Manual Leaning
For higher power settings, "Auto Rich" power settings will be necessary, but usually the engine can be run more economically on a leaner mixture. Unfortunately the FS default function is not very good at it. Radial engines like the Constellation's R-3350 are designed to be run on a leaner mixture than the default Cessna 172. Leaning will save about 100 lbs fuel per hour and engine. In general, power settings higher than 2200 RPM and 140 BMEP (low blower) or 129 BMEP (high blower) require an "Auto Rich" mixture, and below these values a manual lean mixture is recommended for fuel efficiency.

Following the procedure on the real aircraft, we manually lean for a "10% BMEP drop". It is done as follows:

1. Set mixture to 'best' using the "SM" simicon on the right side of the FE panel, this will give you the best mixture setting to start with.
2. Set desired cruise RPM
3. Set throttles for desired BMEP
4. Lean mixture to reduce BMEP value by 10%. You can do that on the keyboard, pressing <Ctrl>-<Shift>-<F2> to lean. If you overdo it, get it back richer by pressing <Ctrl>-<Shift>-<F3>. If you have a mouse with central wheel, you can place the pointer over the mixture levers in FE panel and drag them by moving the mouse wheel. You will find that the BMEP will initially increase but then reduce.
5. Open throttles again to restore BMEP to the desired value.

The leaning process can be simplified by using the Mixture Icons on the main panel. "AL" sets mixture to a "Fuel/Air-Ratio" (FAR) of 0.072 and the "10%" icon 0.064, if mixture levers are in the manual range (below 38%) and altitude is above 4,500 ft.

Once leaning is completed, you might want to cross-check your fuel flow with the Power Table data. If it is more than about 10% off, you might try to repeat the process. You will need to adjust mixture each time you change more than 1000 ft of altitude.

The Status Gauge displays FAR, under "f/a" for each engine. "Auto Rich" values are between 0.084 and 0.105 in real life, but in FS9 you get a constant FAR of 0.084 in "Auto Rich", while a "10% lean" mixture has a FAR of 0.063-

0.065. This might be helpful to learn leaning technique. Apart from that, a real-life FE had the chance to judge mixture by the color of the exhaust flames, which isn't available in FS.

A leaned mixture will not allow you to get full power. You will need to use "Auto Rich" mixture for power settings, with RPM higher than 2200 and BMEP higher than 140 (LB) or 129 (HB). Maximum Power is METO power: 2400 RPM, MAP for 297 BMEP in Low and 177 in High Blower, Mixture AUTO RICH – but this has a very low fuel efficiency and is therefore not used in normal airline service. Maximum cruise power with 10% lean mixture is given in the checklist.

Make sure you return to Auto Rich mixture before step climbing and lean again after leveling off.

You might get warning messages by FS about the wrong mixture if you have the 'Flying tips' checkbox activated in realism settings. Just ignore it or uncheck the feature.

Descent and approach:

Plan for a descent rate of around -500 fpm, or 2 minutes of flying time for every 1,000 ft altitude between cruise altitude and altitude at initial approach fix (IAF). This will allow for several minutes of level flight to bleed off airspeed before arriving at the IAF. Actual descent rates can be higher.

Like similar airliners of the era, the Constellation needs some attention during descent. To avoid shock cooling the engines, power must be reduced carefully at steps of only 3" MAP per minute until 100 BMEP is reached, not much less than cruise power. RPM usually remains at cruise settings. It might be useful to start the first power reduction a minute before you actually start descending to allow the plane to slow down a bit already.

If you start descent from a high altitude, you might initially need to adjust throttle more frequently to avoid MAP and BMEP increasing instead as you descent into denser air. This should allow actual descent rates around 1,000 fpm without exceeding Vne or Mach limit (see above). This will get simpler once you descend into denser air and below the engines' critical altitude. Set Mixture to "Auto Lean" when you descend, otherwise you will have to re-set mixture every few minutes.

You need to shift superchargers to low during descent. While you might not notice a high blower during a normal descent and landing, you have way too much MAP available in case of a go-around and it would cause multiple engine failures in exactly the moment when you cannot afford it.

It is even more critical than in the Super Constellation to arrive at the airfield with the proper speed. Make sure you are at 130 kts with first stage of flaps extended (take-off setting) by the time you reach the initial approach fix. Allow for 3 or 4 minutes level flight at initial approach height in order to slow down. An airspeed of 150 kts is recommended for flap extension, max. flap extension speed is 174 kts, but if you're that fast, you will have to re-trim considerably as speed bleeds off. If you are still too fast, enter a holding pattern to allow airspeed to slow down.

Holding is usually performed in approach configuration – 2100 RPM, 130 kts and 60% flaps. If fuel is critical or a prolonged holding is expected, you may use the "Low Cruise / Holding" power settings instead as given in the Power Table.

The final FE tasks before landing are listed in the "In Range" section of the checklist.

Landing:
The Constellation certainly is a complex aircraft, but it is not particularly difficult to land. You need to keep speed under control, though. The speeds are listed in the checklist:

130 kts and 60% flaps on downwind leg,
120 kts, 80% flaps and gear down on base leg,
approach speed and 100% flaps once on final approach at about 200 ft above ground, reference speed over the threshold (Vat, approach speed minus 10 kts).

The plane usually needs some power all the way to touchdown, typically a MAP between 23-26 inch, but it will float down the runway if approach speed is too high. During the flare, reduce MAP to 15 inch until touchdown, and when on ground close throttles and let the nose wheel settle gently.

Differences between versions:
The aircraft modeled in this package simulates a L-49E Constellation, which was becoming available only after strengthening earlier types to allow the associated higher operating weights. In fact, the L-49E has a higher MTOW than the later L-649. As mentioned in the historical note, Constellations were delivered with lower operating weight limits. Please restrict the operating weights if you want to simulate earlier versions. You will notice that performance increases considerably at lower weights.

Please note that before mid-1947, only single-speed superchargers were installed and high blower was not available then. The earlier engines do not tolerate manual leaning beyond the 'Auto Lean' position, either, which will result in a higher fuel consumption. For the C-69 and early L-49 operations, only use low blower and lean mixture by setting mixture into the 'AUTO LEAN' position. This will result in a slightly higher fuel consumption (about 7.5%).

The first 62 aircraft did not have a steerable nosewheel, but needed to be steered by using differential throttles and brakes. It can be simulated by changing the [contact_points] section of the aircraft.cfg file. However, this will require at least dual throttles for your FS setup. You will not be able to control the aircraft adequately by using a joystick with a single throttle alone.

6. The Team

Volker Böhme:	GMAX, research, procedures, documentation
Luis Pallas:	flight dynamics and gauges
Bill Tyne:	wingview angles, lights, exhaust effects
Stefan Werner:	Textures, flight test

Further contribution:

Maarten Brouwer:	Textures (KLM)
Doug Dawson:	Supercharger and Fuel Dump code
Frank Gonzales:	Textures (TWA)
Hans Hermann:	Textures (PAA)
Manfred Jahn:	Original GMAX files, support and modelling
Hans-Jörg Naegele:	Original panel
Milton Shupe:	Gauge code and textures
Jan Visser:	Original VC textures
John H. White:	Original engine model

In memory of John Howard White (FsDzign)

Reference Data

V-Speeds

TAKE OFF				
		Take off Speeds (Flaps UP)		
Weight (lb)		**V1**	**Vr**	**V2**
95000		100	108	116
90000		97	105	113
85000		93	101	109
80000		91	99	107
75000		88	96	104
70000		87	95	100
		Take off Speeds (Flaps 60%)		
Weight (lb)		**V1**	**Vr**	**V2**
95.000		88	96	104
90.000		85	93	101
85.000		83	91	99
80.000		82	90	98
75.000		82	90	98
70.000		82	90	98

Note: IAS is about 2-3 kt lower than CAS (see airspeed correction table in section 5)

V take off = V2 V climb out = V2 + 5

LANDING						
		Flaps 100%			**Flaps 80%**	
Weight (lb)		**Vapp**	**Vthr**		**Vapp**	**Vthr**
85.000		111	101		113	103
80.000		108	98		110	100
75.000		105	95		107	97
70.000		101	91		104	94
65.000		97	87		100	90
60.000		95	85		97	87
55.000		92	82		95	85

	Stall speeds (KCAS)	
Weigth (lb)	Gear DN Flaps UP	Gear DN Flaps DN
55000	77	61
57000	78	62
67500	85	67
75000	89	70
80000	92	73
85000	95	75
90000	98	77
95000	100	79

2.- ENGINE POWER SETINGS

Power settings	Blower	BHP	RPM	BMEP	Critic. Altit.	Switch Altit.	Mixture	CHT (ºC)
Take Off	LB	2200	2800	186	6.300		AR	< 260
	HB	1900	2600	173	16.200		AR	< 260
METO	LB	2000	2400	197	4.800	9.000	AR	< 232
	HB	1800	2400	177	15.000	-	AR	< 232
Cruise Climb	LB	1300	2300	134	16.500	18.000	AR	< 232
low	HB	1200	2300	123	-	-	AR	< 232
Cruise Climb	LB	1400	2300	144	14.500	14.500	AR	< 232
high	HB	1400	2300	144	-	-	AR	< 232
Max. Cruise	LB	1300	2200	140	13.000	15.000	AL	< 232
	HB	1200	2200	129	-	-	AL	< 232

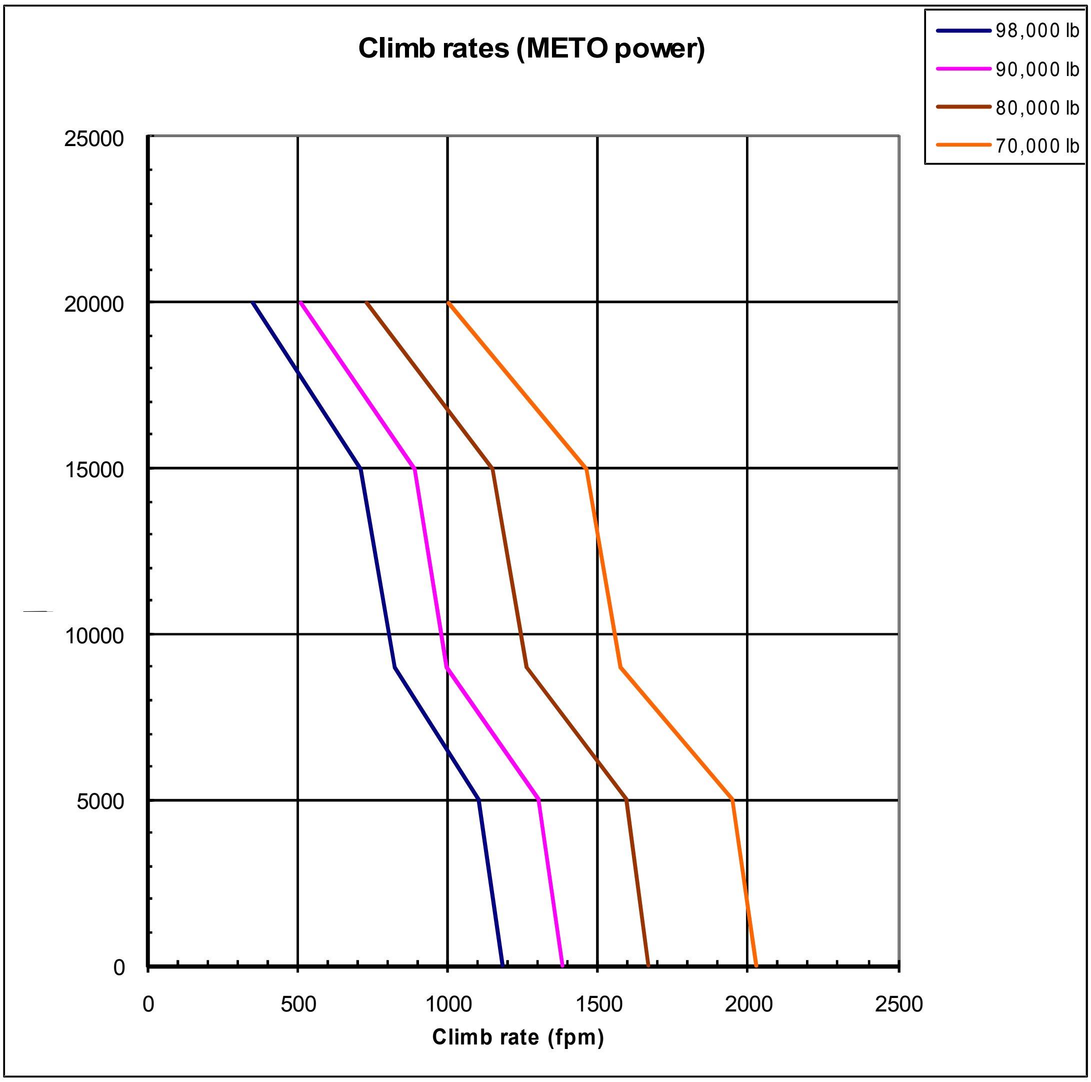
3.- TAKE OFF AND LANDING DISTANCES.

TAKE OFF DISTANCES						
	S.L.		3000 ft		6000 ft	
TOW (lb)	Ground run	50 ft obstacle	Ground run	50 ft obstacle	Ground run	50 ft obstacl
70.000	1330	2035	1515	2310	1985	3000
80.000	1780	2740	2060	3140	2720	4280
93.000	2550	3910	2970	4510	3910	6040
Conditions: T.O power, no wind, hard surface.						

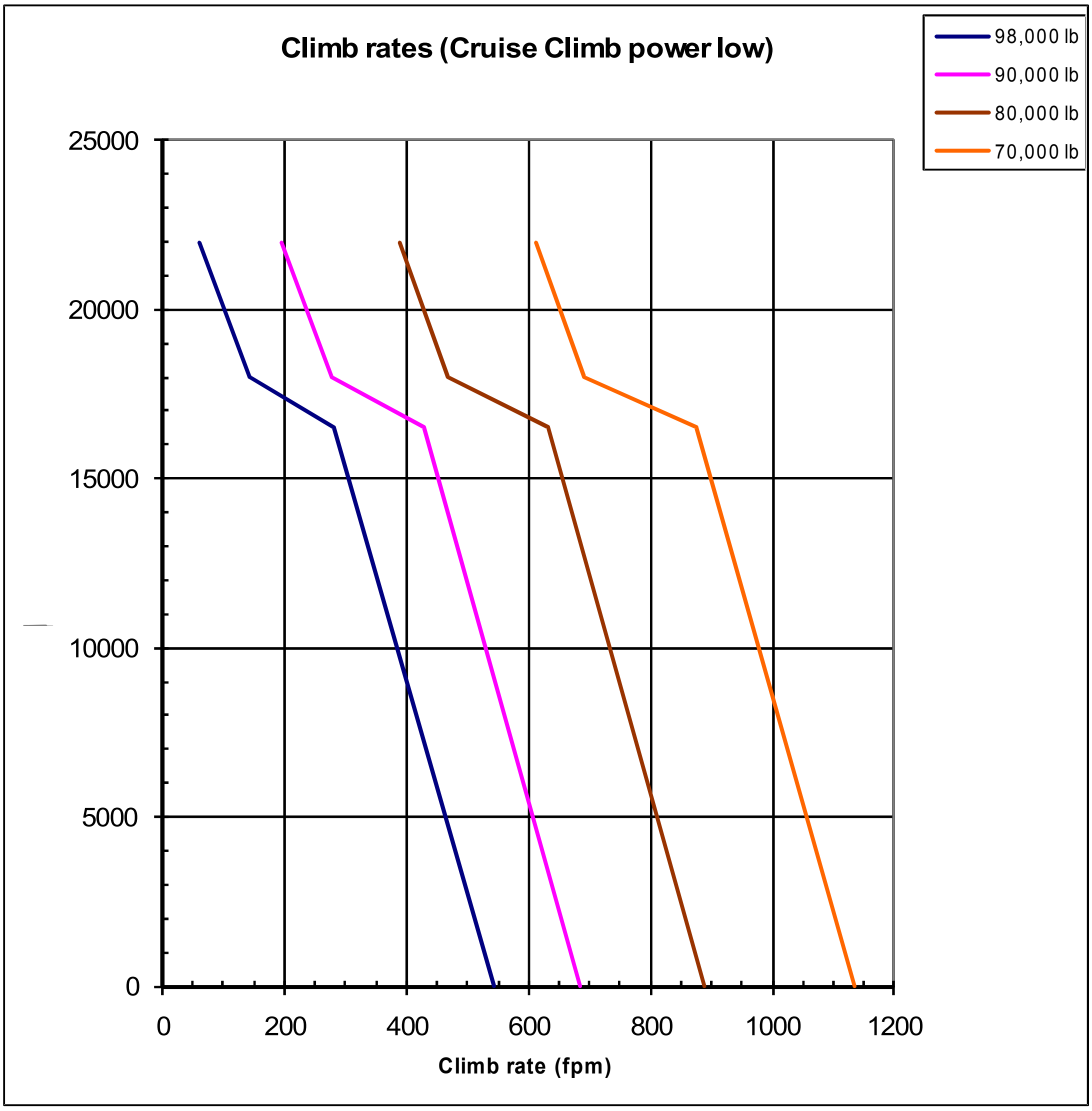
LANDING DISTANCES						
	S.L.		3000 ft		6000 ft	
LW (lb)	Ground roll	50 ft obstacle	Ground roll	50 ft obstacle	Ground roll	50 ft obstacl
55.000	975	2280	1055	2400	1140	2580
75.000	125	2750	1320	2970	1430	3140
Conditions: Hard dry surface.						

4.- CLIMB

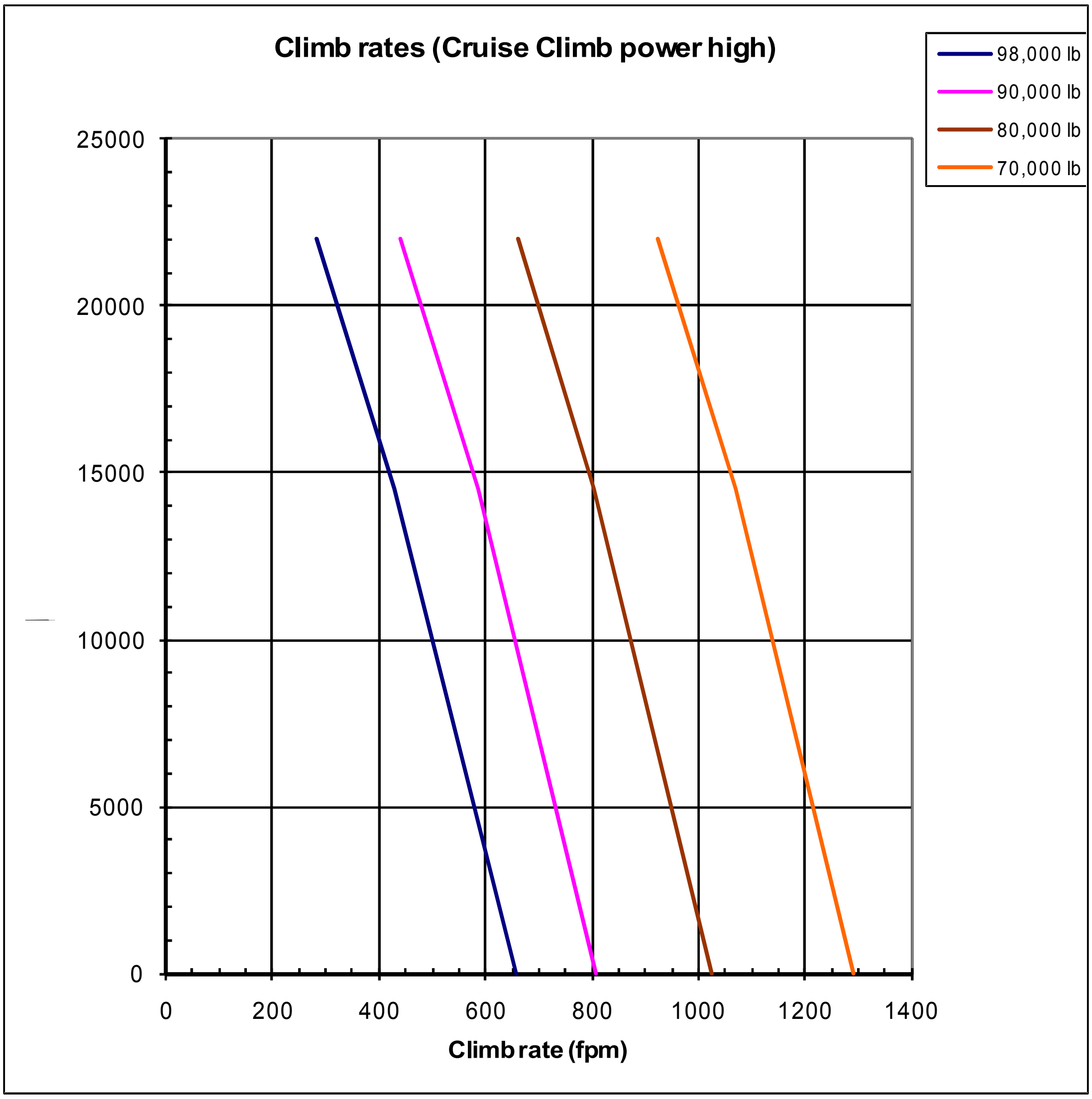
METO CLIMB:
Climb speed: 150 KIAS.
METO power, switch to HB at 9,000 ft altitude.
Flaps and gear up.
Data for cowl flaps 100% open.
Maintain CHT below 232 ºC



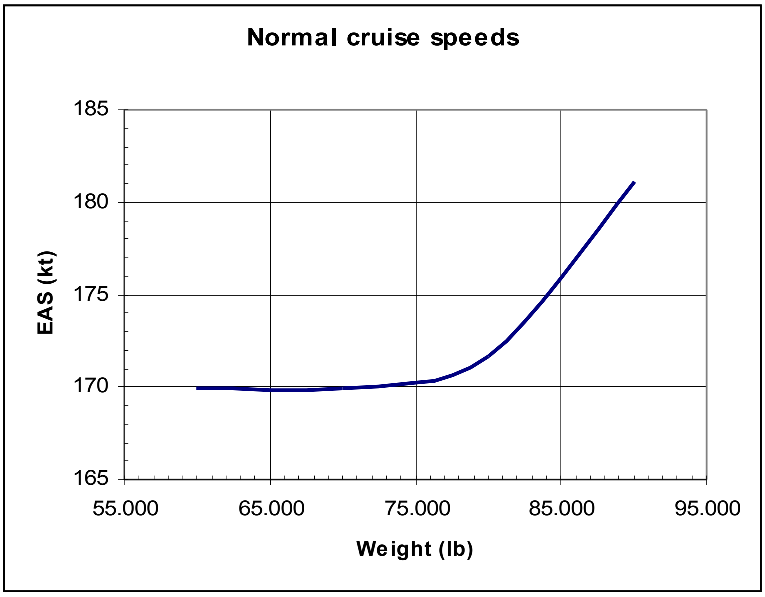
NORMAL CLIMB LOW:
Climb speed: 150 KIAS.
Cruise climb power low (1300 bhp in LB and 1200 bhp in HB), switch to HB at 18,000 ft altitude.
Flaps and gear up
Data for cowl flaps faired (25% open).
Maintain CHT in the range 180-210 ºC



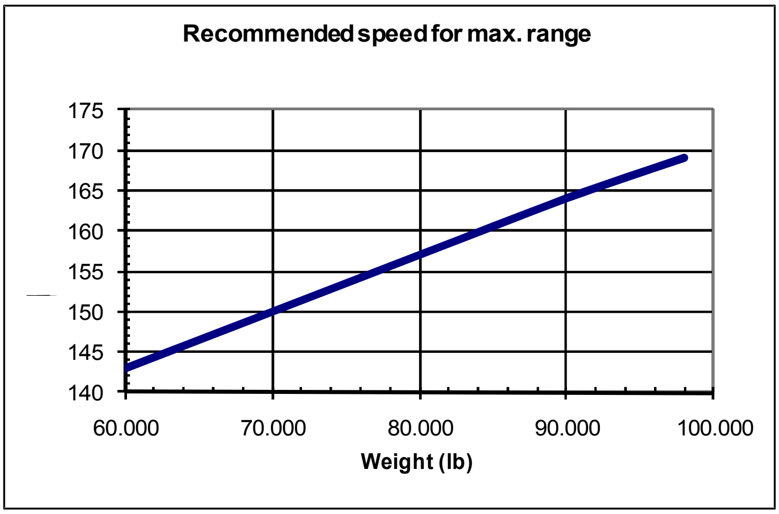
NORMAL CLIMB HIGH:
Climb speed: 150 KIAS.
Cruise climb power high (1400 bhp both in LB and in HB), switch to HB at 14,500 ft altitude.
Flaps and gear up
Data for cowl flaps faired (25% open).
Maintain CHT in the range 180-210 ºC



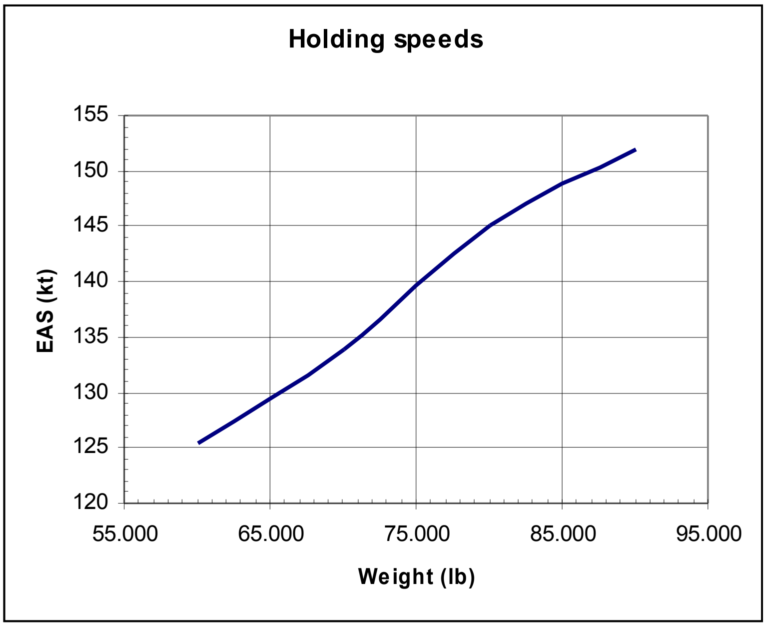
5.- CRUISE



Normal cruise speeds
185
180
175
170
165
EAS (kt)
55.000
65.000
75.000
85.000
95.000
Weight (lb)



Recommended speed for max. range
175
170
165
160
155
150
145
140
60.000
70.000
80.000
90.000
100.000
Weight (lb)

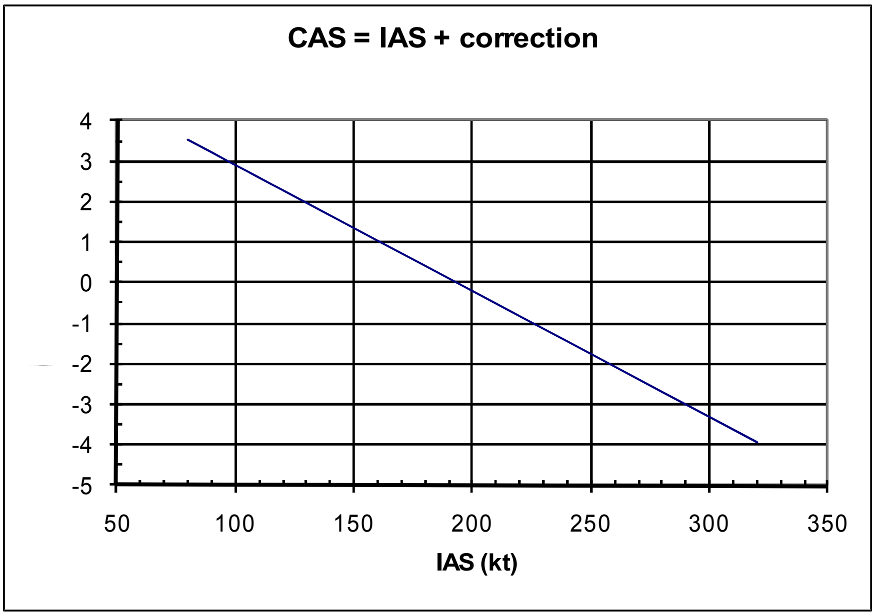


Holding speeds
155
150
145
140
135
130
125
120
EAS (kt)
55.000
65.000
75.000
85.000
95.000
Weight (lb)

Best speed normal cruise operating altitude				
Weight (lb)	Altitude (ft)	EAS (kt)	TAS (kt)	nm/100 lb
90000	18000	181	239	11,0
80000	22000	172	243	12,2
70000	22000	171	242	13,2
60000	22000	170	240	14,4

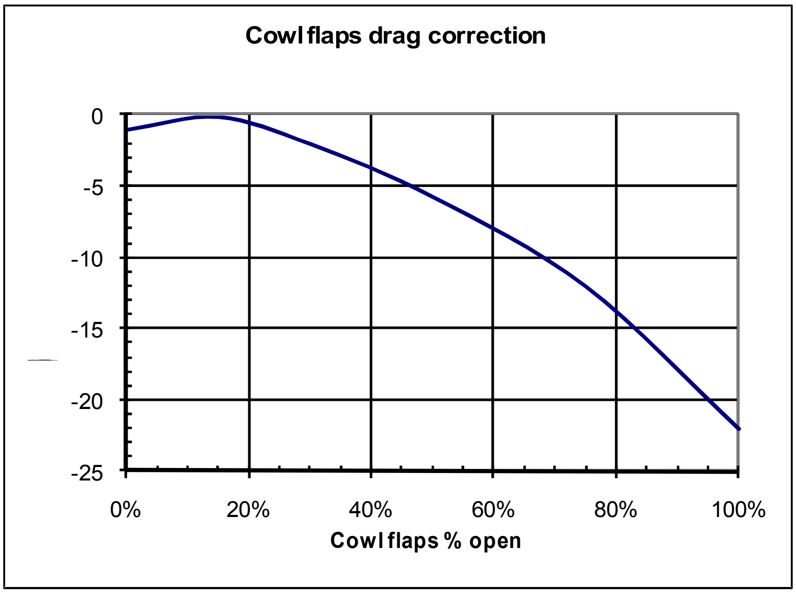
Speed correction table	CAS = EAS + speed corr.				
	EAS (kt)				
Altitude (ft)	150	175	200	225	250
0	0	0	0	0	0
5000	-1	-1	-1	-1	-1
10000	-2	-2	-2	-3	-3
15000	-2	-3	-3	-4	-4
20000	-4	-4	-5	-5	-6

13. **Airspeed correction table** (instrument position error):



14. Cowl flaps drag correction:

Correction on table cruise speeds (KIAS)



Lockheed L049		Cruise settings			
Weight	**90,000 lb**				
Altitude (ft)	**5.000**	**10.000**	**14.000**	**18.000**	**22.000**
Max cruise (*)					
BHP	1303	1303	1266	1200	1107
RPM	2200	2200	2200	2200	2200
BMEP	140	140	136	129	119
EAS	211	204	194	181	162
TAS	228	238	241	239	229
FF	565	570	560	545	510
SFC	0,434	0,438	0,442	0,454	0,461
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	10,09	10,44	10,76	10,96	11,23
Normal cruise					
BHP	977	1077	1128	1200	1107
RPM	1650	1900	2100	2200	2200
BMEP	140	134	127	129	119
EAS	181	181	181	181	162
TAS	195	211	225	239	229
FF	420	465	500	545	508
SFC	0,430	0,432	0,443	0,454	0,459
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	11,61	11,34	11,25	10,96	11,27
Min. cruise/Holding					
BHP	810	872	940	1007	1089
RPM	1450	1650	1900	2000	2200
BMEP	132	125	117	119	117
EAS	152	152	152	152	153
TAS	164	177	189	201	217
FF	350	380	415	452	495
SFC	0,432	0,436	0,441	0,449	0,455
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	11,71	11,64	11,39	11,12	10,96
(*) Max. Cruise power is 1300 bhp LB and 1200 bhp HB, mixture auto lean					

Cruise setting notes (for all weights):

1. Cowl flaps faired (25% open). See cowl flaps drag correction table for other cowl flaps settings.
2. Maintain CHT in the range 180-210 ºC
3. For Auto Lean mixture, Fuel Flow will increase about 7.5%.

Lockheed L049		Cruise settings			
Weight	**80,000 lb**				
Altitude (ft)	**5.000**	**10.000**	**14.000**	**18.000**	**22.000**
Max cruise (*)					
BHP	1303	1303	1266	1200	1107
RPM	2200	2200	2200	2200	2200
BMEP	140	140	136	129	119
EAS	215	206	200	188	174
TAS	232	240	248	249	246
FF	565	570	560	545	510
SFC	0,434	0,438	0,442	0,454	0,461
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	10,27	10,53	11,07	11,42	12,06
Normal cruise					
BHP	837	893	956	1024	1098
RPM	1465	1675	1900	2000	2200
BMEP	135	126	119	121	118
EAS	171	172	173	172	173
TAS	185	200	214	228	244
FF	365	390	425	455	500
SFC	0,436	0,437	0,444	0,445	0,455
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	12,67	12,82	12,59	12,53	12,20
Min. cruise/Holding					
BHP	693	767	810	876	902
RPM	1400	1550	1725	1850	2050
BMEP	117	117	111	112	104
EAS	145	145	145	145	145
TAS	156	169	180	192	205
FF	303	335	358	390	410
SFC	0,437	0,437	0,442	0,445	0,455
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	12,87	12,61	12,57	12,31	12,50
(*) Max. Cruise power is 1300 bhp LB and 1200 bhp HB, mixture auto lean					

Lockheed L049		Cruise settings		
Weight	**70,000 lb**			
Altitude (ft)	**5.000**	**10.000**	**14.000**	**18.000**	**22.000**
Max cruise (*)					
BHP	1303	1303	1266	1200	1107
RPM	2200	2200	2200	2200	2200
BMEP	140	140	136	129	119
EAS	219	211	205	194	182
TAS	236	246	254	257	258
FF	565	570	560	545	510
SFC	0,434	0,438	0,442	0,454	0,461
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	10,44	10,79	11,34	11,79	12,65
Normal cruise					
BHP	758	824	872	932	1007
RPM	1400	1610	1825	1900	2125
BMEP	128	121	113	116	112
EAS	171	170	170	171	171
TAS	184	198	211	226	242
FF	330	360	384	415	460
SFC	0,435	0,437	0,440	0,445	0,457
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	13,94	13,75	13,74	13,61	13,15
Min. cruise/Holding					
BHP	563	613	656	683	743
RPM	1400	1420	1600	1700	1850
BMEP	95	102	97	95	95
EAS	133	134	134	135	134
TAS	144	156	166	178	190
FF	245	270	295	305	340
SFC	0,436	0,441	0,449	0,446	0,457
Blower	LB	LB	LB	LB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	14,69	14,44	14,07	14,59	13,97
(*) Max. Cruise power is 1300 bhp LB and 1200 bhp HB, mixture auto lean					

Lockheed L049		Cruise settings			
Weight	**60,000 lb**				
Altitude (ft)	**5.000**	**10.000**	**14.000**	**18.000**	**22.000**
Max cruise (*)					
BHP	1303	1303	1266	1200	1107
RPM	2200	2200	2200	2200	2200
BMEP	140	140	136	129	119
EAS	224	217	210	197	189
TAS	242	253	260	261	267
FF	565	570	560	545	510
SFC	0,434	0,438	0,442	0,454	0,461
Blower	LB	LB	LB	HB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	10,71	11,10	11,61	11,97	13,09
Normal cruise					
BHP	693	749	799	866	910
RPM	1400	1500	1750	1950	2050
BMEP	117	118	108	105	105
EAS	170	170	170	171	170
TAS	183	198	211	226	240
FF	302	330	355	390	418
SFC	0,436	0,441	0,444	0,450	0,459
Blower	LB	LB	LB	LB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	15,15	15,00	14,86	14,49	14,35
Min. cruise/Holding					
BHP	456	484	521	558	600
RPM	1300	1300	1400	1500	1650
BMEP	83	88	88	88	86
EAS	125	125	125	125	125
TAS	135	146	155	165	177
FF	200	214	233	250	273
SFC	0,438	0,442	0,447	0,448	0,455
Blower	LB	LB	LB	LB	HB
Mixture	10% lean	10% lean	10% lean	10% lean	10% lean
nm/100 lb	16,88	17,06	16,63	16,50	16,21
(*) Max. Cruise power is 1300 bhp LB and 1200 bhp HB, mixture auto lean					

6.- LIMITATIONS:

Engine: Wright Cyclone 745C18BA-3

Power limits	Low Blower		High Blower	
Take Off (max 5 min.)				
	S.L	6,300 ft	10,600 ft	16,200 ft
BHP	2200	2200	1900	1900
RPM	2800	2800	2600	2600
BMEP	186	186	173	173
Max MAP (inch)	46	44	44	42
Max. Continuous (METO)				
	S.L	4,800 ft	8,000 ft	15,000 ft
BHP	2000	2000	1800	1800
RPM	2400	2400	2400	2400
BMEP	197	197	177	177
Max MAP (inch)	43,5	41,5	43	40

Max RPM for Auto Lean	2200	
Max BMEP for Auto Lean		
Low Blower	140	(1300 bhp)
High Blower	129	(1200 bph)

Speed Limitations		
		L-049
Max IAS level flight or climb (kt)		261
Max IAS glide or dive (kt)		236
Flaps extended		
Take off position		174
Approach or landing position		127
Gear extended		152
Vmc (ground)		95

Weight limitations:

	MTOW (lbs)	MLW (lbs)
C-69	86'250	75'000
L- 49	86'250	75'000
L- 49A	90'000	77'800
L- 49D	96'000	83'000
L- 49E	98'000	84'500
L-149	100'000	83'000

CoG limits:

Forward CoG limit % MAC): 20% for T.O., 18% for cruising flight and landing.
Aft CoG limit (% MAC): 32%

Checklist for Lockheed L-49

Before starting engines

[ ] Communication	Radio GROUND/TOWER FREQUENCY
[ ] Parking Brake	SET
[ ] De-Icer Boots, Anti-Icer	OFF
[ ] Generator Switches	ON
[ ] Inverter	ON, CHECK
[ ] Cowl Flaps	OPEN 100%
[ ] Carburetor	Air COLD
[ ] Propellers	FULL RPM
[ ] Fuel Tanks	CHECK FUEL QUANTITIES
[ ] Fuel Tank Selector	SELECT TAKEOFF TANKS: 1, 2, 3, 4
[ ] Mixtures	CUT OFF
[ ] Engine Area	AREA CLEAR, POST FIRE GUARD
[ ] Note oil temperature	
[ ] Ground power	ON if required

Starting engines

[ ] Start engine 3 first
  a. Throttle Lever APPROXIMATELY 1200 RPM (6-8%)
  b. Engines Start Selector Switch SET TO ENGINE 3
  c. Start Switch ENGAGE, ROTATE PROP SIX BLADES
  d. Ignition Switch ENGINE 3, BOTH
  e. Auxiliary Fuel Pump ENGINE 3, LOW
  f. Prime AS REQUIRED
  g. Mixture Lever between IDLE and LEAN
  h. Hold Start Switch until Ignition Light goes out (Maximum 30 seconds)
  i. When engine has started, quickly move it to position AUTO RICH
  j. Oil Pressure   Check for rise in pressure
  k. Auxiliary Fuel Pump ENGINE 3, OFF
[ ] Start engine 4 next, procedures a to k
[ ] Ground power OFF
[ ] Start engine 2, then 1, procedures a to k
[ ] Engine Start Selector Switch SET TO OFF
[ ] Run engines at 1000 RPM until oil inlet temperature at least 75°C
  or 10°C above prestarting temperature and oil pressure is stabilized

LINEUP

[ ] Anti-Collision Lights	ON
[ ] Landing Lights	ON
[ ] Exterior Lights	AS REQUIRED
[ ] Engine Instruments	ALL NORMAL (within green bands)
[ ] Propellers	FULL INCREASE (2800 RPM)
[ ] Auxiliary Fuel Pumps	HIGH
[ ] Mixtures	AUTO RICH
[ ] Cowl Flaps	SET 50%
[ ] CHT	LESS THAN 200°C
[ ] Oil Temperature	OVER 40°C

TAKEOFF / CLIMB

Warning: 2 min time limit for takeoff power

Warning: Do not overboost engine, keep MAP below 46"

[ ] V speeds will be called out	
[ ] Wing Flaps	60% (TAKEOFF, Stage 1)
[ ] Trim	+1.7
[ ] Brakes	ON
[ ] Throttles	35"
[ ] Brakes	RELEASE
[ ] Throttles	MAX POWER (2200 HP at 46")
[ ] Vr	Rotate (V2 minus 10 kts)
[ ] V2	Fly Off
[ ] Establish climb, VSI <= 500 fpm	
[ ] Landing Gear	UP
[ ] Accelerate to 120 kts at VSI <= 500 fpm	

Climb Stage 1: METO Power (2000 HP)

[ ] Throttles	43.5"
[ ] Propellers	2400 RPM
[ ] Climb above 500 ft AGL and above all obstructions	
[ ] Accelerate to 130 kts	
[ ] Wing flaps up	
[ ] Accelerate to 150 kts	
[ ] Cowl flaps	50%, CHT max. 230°C

Climb stage 2: Climb power (1400 HP, low blower)

Plan 4 * 780 = 3120 lbs/hr and climb rate 500 ft/min

[ ] Throttles	33", adjust for 144 BMEP
[ ] Propellers	2300 RPM
[ ] Auto Pilot	CHECK, SET, ON
[ ] Cowl flaps	25%, max. CHT 230°C
[ ] Mixtures	AUTO RICH
[ ] Fuel tanks	climb tanks
[ ] Auxiliary Fuel Pumps	LOW
[ ] Engine Instruments	Check
[ ] Oil Pressure	CHECK
[ ] Throttles	Adjust to 144 BMEP during climb

Blower Shift

Note: HIGH supercharger gear not available in BA-1 engines

[ ] Above 14'000 ft altitude shift supercharger gear ratio to HIGH:

[ ] Level off

[ ] MAP 20"

[ ] 1600 RPM

[ ] Do not allow IAS to decay below 150 kts

[ ] Shift blowers to HIGH

[ ] Resume Climb in high blower

Climb stage 3: Climb power, high blower (1400 HP)
Note: HIGH supercharger gear not available in BA-1 engines
Plan 4 * 750 = 3000 lbs/hr and climb rate 500 ft/min

[ ] MAP 33"	// for 144 BMEP
[ ] 2300 RPM	
[ ] Cowl Flaps	25%, max. CHT 230°C
[ ] Mixture	AUTO RICH
[ ] Altimeter	ABOVE FL 180 set to 29.92 In. Hg.
[ ] Throttles	Adjust to 144 BMEP during climb

[ ] Maintain IAS=150 kts, If climb rate decays below 500 fpm, level off and begin cruise segment.

CRUISE

[ ] Accelerate to cruise speed while still in Climb Power
WARNING: No Machmeter – to avoid transonic shock: Vno 236 knots, above FL160 reduce speed 4 knots for each additional 1000 ft
Note: 10% LEAN mixture not permitted in BA-1 engines, use AUTO LEAN instead. Plan for 7.5% more fuel burn.

[ ] Set Cruise Power
For details refer to cruise control chart and Engine power schedule. Simplified power settings below.

A: MAXIMUM CRUISE POWER in AUTO LEAN mixture (about 1300 HP LB)
    [ ] MAP 30”, adjust for 140 BMEP
    [ ] 2200 RPM
    [ ] Mixture 10% LEAN
    // yields 238 kts TAS / 204 kts IAS at FL100 and 90,000 lbs
    // FF 4 x 570 = 2280 lbs/hr
B: Normal CRUISE POWER (about 1000 HP)
    [ ] MAP for 120 BMEP (about 28")
    [ ] 2000 RPM
    //yields 228 kts TAS / 172 kts IAS at FL 190 and 80,000 lb
    //FF 4 x 455 = 1820 lbs/hr
C: LOW CRUISE POWER/HOLDING (about 770 HP)
    [ ] MAP for 117 BMEP (about 26")
    [ ] 1550 RPM
    //Yields 145 kts IAS / 169 TAS at 80,000 lb and FL100
    //FF 4 x 335 = 800 lbs/hr

[ ] Lean Mixture for 10% drop in BMEP
[ ] Open throttle for target BMEP

[ ] Cowl flaps closed to 25%, max. CHT 230°C,	recommended CHT 170-210°C
[ ] Fuel Tanks	SELECT AS REQUIRED
[ ] Engine Instruments	MONITOR

[ ] If Elevator Trim =< 0° step climb or reduce power, maintain pitch <= 4°

INITIAL DESCENT

Descent should be planned at a sufficient distance so as to reach the desired altitude at the proper time without the use of flaps. Plan for a Rate of Descent of about 500 fpm.

Airspeed limits: Max. 261 kts, above FL170 reduce speed 5 knots for each additional 1000 ft

[ ] Auto Pilot	OFF
[ ] Cowl Flaps	Closed or 10%
[ ] RPM	1800 or Cruise RPM

[ ] Reduce MAP by 3" per min to avoid shock cooling until BMEP 100
[ ] MAP minimum 18”
[ ] Auto Pilot ON when descent is stabilized
[ ] Mixture AUTO LEAN
[ ] When passing FL 180, RESET ALTIMETER (to local pressure)
[ ] When passing 16,000 ft, switch blowers to LOW.
[ ] Mixtures AUTO RICH
[ ] CALCULATE Landing Weight
[ ] dump fuel if gross weight when landing will be over 84,500 lbs.(L-49E)

Holding

Plan 4 * 300 = 1200 lbs/hr at 80,000 lbs and FL050
[ ] Low Blower
[ ] Mixture 10% Lean
[ ] 1400 RPM
[ ] 152 kts
[ ] Set mixture to Auto Rich when beginning approach

In Range / Arrival Phase

[ ] Review landing speeds
Max landing weight 84,500 lbs. gross weight (L-49E).
Vapr above the following gross weights in lbs:
85,000 - 114 kts.
80,000 - 111 kts.
75,000 - 108 kts.
70,000 - 104 kts.
65,000 - 100 kts.
60,000 - 98 kts.
55,000 - 95 kts.
Threshold Speed Vat is 13 Kts. less than Vapr.

[ ] Mixture	AUTO RICH
[ ] Fuel tanks to Landing tanks	
[ ] Carburetor Air	COLD and RAM, if no icing conditions are present, else use ALTERNATE air
[ ] De-Icer boots off	
[ ] Auxiliary Fuel Pumps	HIGH
[ ] Mixture	AUTO RICH
[ ] Low Blower	
[ ] Cowl Flaps	30%
[ ] Landing Lights	ON
[ ] Auto Pilot	OFF
[ ] Airspeed	REDUCE POWER for 130 Kts.
[ ] Wing Flaps	60% at 150 kts
[ ] Propellers	2100 RPM

BEFORE LANDING / LANDING

[ ] Throttles for IAS of 130 kts by downwind or landing-approach fix

On turning Base Leg:

[ ] Propellers	2400 RPM
[ ] Airspeed	130 kts.
[ ] Landing Gear	DOWN and LOCKED

On turning Final or intercepting ILS Glide Slope:

[ ] Airspeed	120 kts.
[ ] Wing Flaps	80%
[ ] Slow to Vapr.	

When landing assured (at about 200 ft AGL):

[ ] Wing Flaps 100%
[ ] Reduce power to reach Vat (Vat is 10 Kts. less than Vapr.) over threshold
[ ] Reduce power to 15 inch MAP at flare
[ ] Touchdown
[ ] Close throttles
[ ] No hard braking before nosewheel on ground
[ ] Lower nosewheel, then steer with nosewheel

[ ] Propellers	FULL RPM
[ ] Cowl Flaps	OPEN 100%
[ ] Auxiliary Fuel Pumps	OFF

AFTER LANDING

[ ] Pitot Heating	OFF
[ ] Wing Flaps	UP
[ ] Landing Lights	OFF
[ ] Anti-Collision Lights	OFF
[ ] Propeller Synchronizer	OFF
[ ] Elevator Trim	+1.7