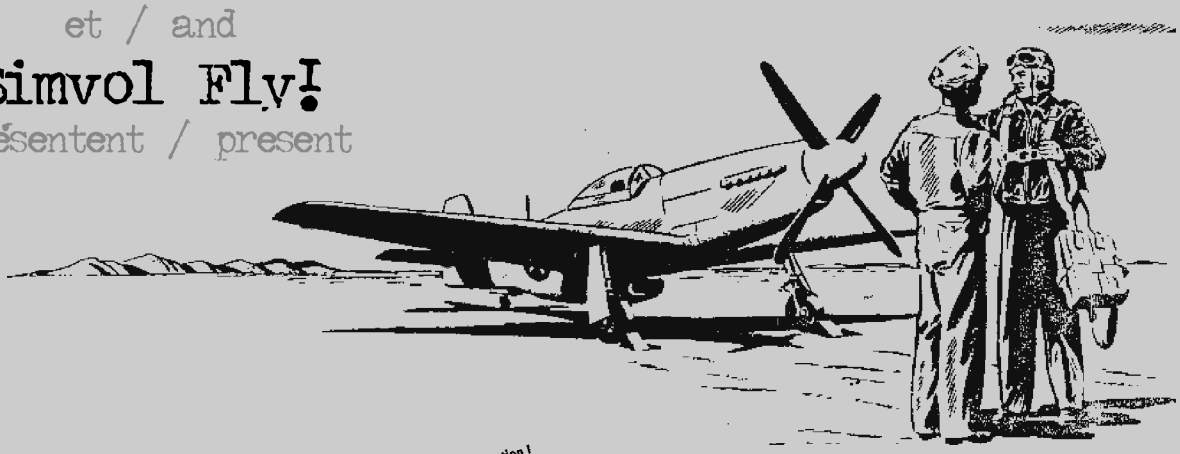
ROTW

French Developers Team

et / and

Simvol Fly!

présentent / present



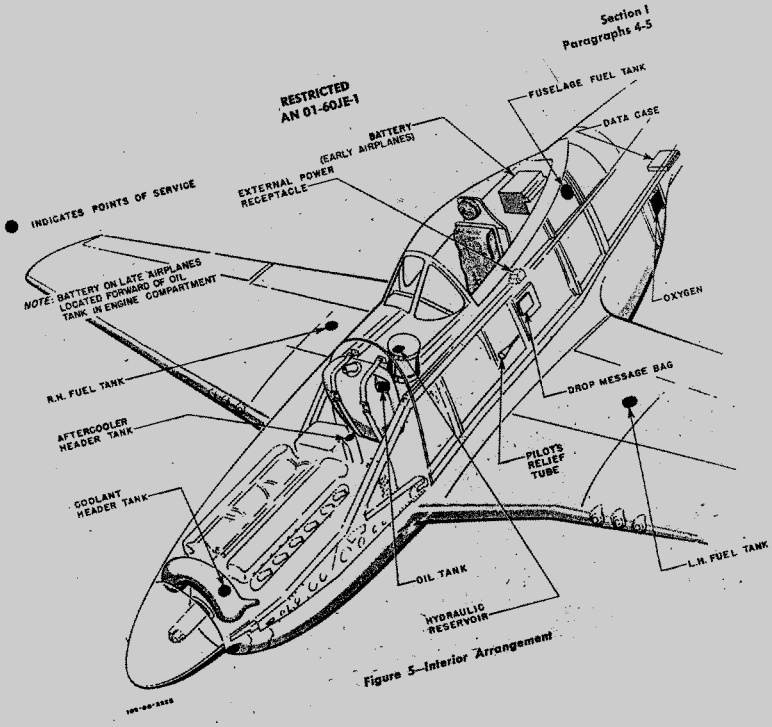


Figure 5—Interior Arrangement

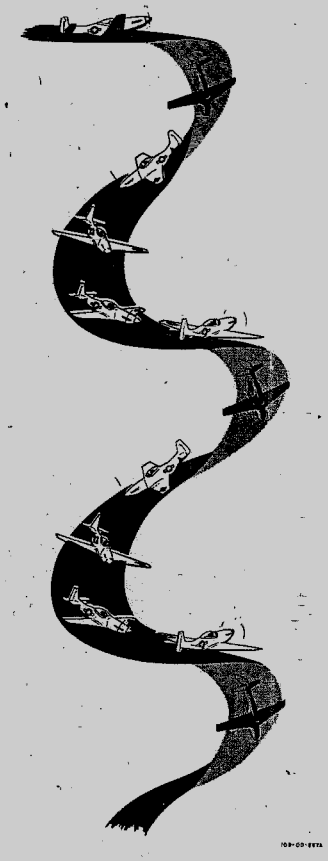


Figure 24—Spin Characteristics

P51-D Mustang

Manuel de vol pour
Flight manual for
Fly! II

Introduction

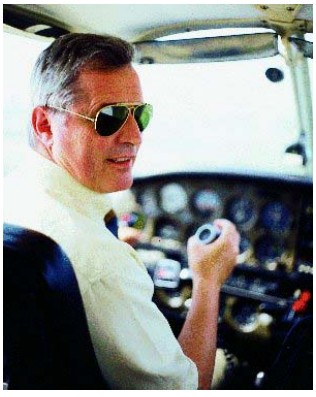
Fly ! is one of the first simulators to offer a complete panel, a realistic cockpit and the possibility to start a plane as in reality.

Of course, like in all major flight simulators, a key (in this case the "E" key) allows you to bypass this stage and start your flight with the engine(s) ON and only the radios to tune.. That is a pity for the starting up of the engines is a very interesting stage of the pre-flight check-list. The strictness of the procedures will allow one to be sure of the airworthiness of the plane.

The more sophisticated the plane (multi-engined, turbo-props, jets) the longer and complex this step will be. Even for a single-engined piston driven aircraft, the check-list must be carefully followed. Skipping a part or trusting only one's memory or habits are the cause of major accidents.

This manual, **only meant for flight simulators** will allow the P51D user to become familiar with the real-world procedures of starting the plane. Even though the P51D is a WWII plane, it is still often seen in air shows. It is a classic, complex and robust plane. Starting it up and hearing the roar of the Rolls Royce Merlin is a not-to-be-missed treat.

René Birot
Simvol/Fly Webmaster
ROTW coordinateur
Private pilot LFRN



Contents

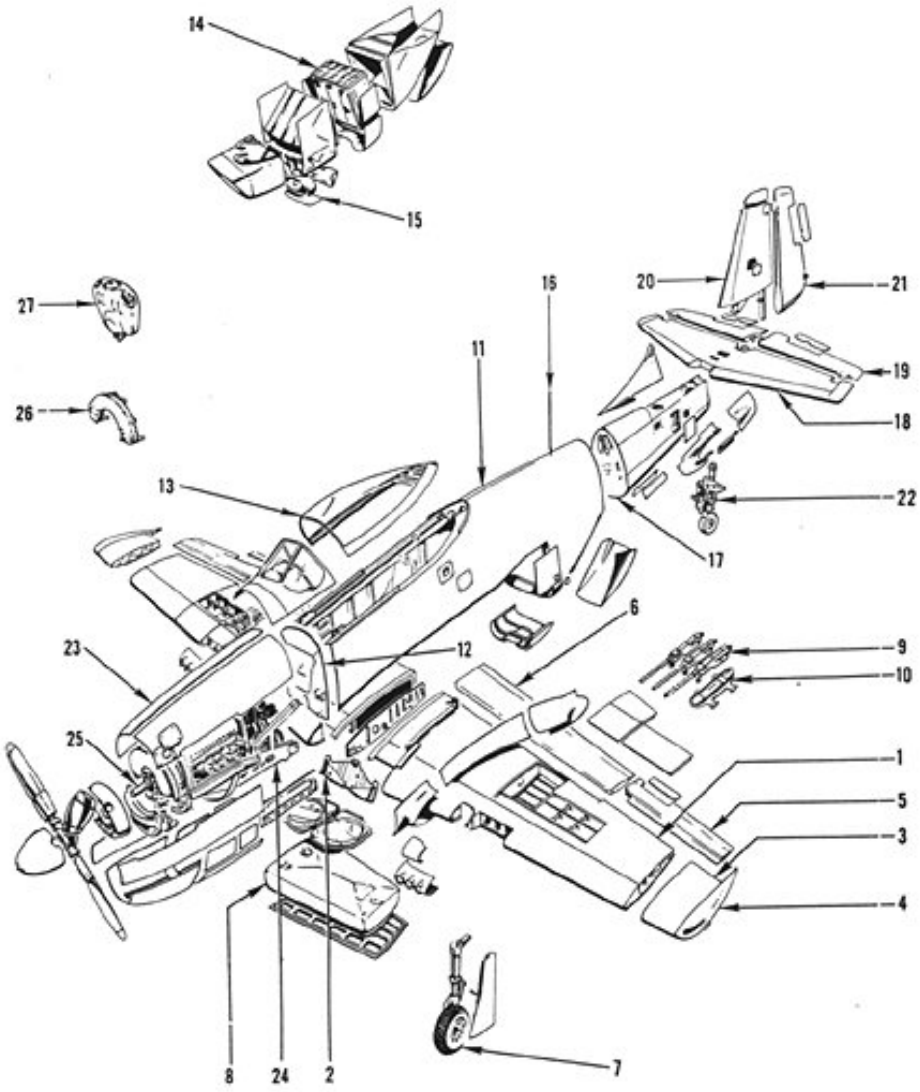
Observation :

All the screenshots were made in Fly ! II except :
- The picture page 19 (Yves Duval's Mustang)
- the 3 pictures page 24

All the procedures are based on the real check-list

1. Guided visit of the P51D Mustang for Fly !

1.1 Outside view (screenshot made in Fly! II)



1.2 The panel

The most of panel indicators are specific and have been built by ROTW (with specific DLL)

As always at the ROTW, we want the startup procedure to as realistic (and complex) as the real one which means that all the instruments, buttons, knobs and levers to be “wired”
The Mustang is a very “high” plane with a tail wheel so the front view while on the ground is very limited. Therefore we decided to separate that view in 2 : a “high” view which allows you to see outside and a “low” view on which you can visualize the majority of the instruments as well the horizon on the sides.

Documentation was harder to find than for our previous aircraft but Jean Baruch provided us with the essentials.

You will not find such an aircraft on every airport so we contacted Aérorétro, an organisation (based in St Rambert d’Albon near Lyon – France) which owns about 15 warbirds including a Mustang, to validate flight model, panel and flight procedures. Their president, Christian Mafré, also a P51 pilot, kindly accepted to help us.

Complete panel : (assembly of the upper, lower, right and left views).

1-3 The instruments:

1.3.1 The main panel :

1- Not used
2 - ADF
3 - Clock
4 – Gun sight (not operational)
5 - Suction gauge
6 - Manifold pressure gauge
7 - Coolant temperature gauge
8 - Tachometer
9 - Carburetor air temperature indicator
10 - Airspeed indicator
11 - Altimeter
12 - Directional gyro
13 - Flight indicator
14 - Bank and turn indicator
15 – Rate of climb indicator
16 – Accelerometer
17 – Oil temperature and fuel and oil pressure gauge

1.3.2 The lower part of the panel

1 – Supercharger switch
2 – “Supercharger ON” warning light
3 – Fuel pump switch
4 – Oil dilute switch (Oil dilution is to introduce fuel into the oil before shutdown when required by extremely cold weather conditions)
5 – Starter
6 - Primer
7 – Landing gear position indicator light
8 - Ignition selector
9 – Parking brake lever
10 – Fairing door emergency control
11 – Fuel tank selector
12 – Fuel shut-off control
13 – Hydraulic pressure gauge
14 – Landing gear lever

1.3.3 Left hand side

1 – Propeller control
2 – Throttle control
3 - Mixture control
4 - Aileron trim tab control knob
5 - rudder trim tab control knob
6 - elevator trim tab control knob
7 – Ram air control
8 – Panel light control selector
9 – Landing lights switch
10 – Oil radiator air control switch
11 – Coolant radiator air control switch
12 – Carb heat

1.3.4 Right hand side

1 – Alternator
2 – Battery
3 – Pitot heat
4 – Navigation lights
5 – Stobes
6 – Ammeter
7- – Panel light control selector

7- ADF
8- 760 channels VHF radio
9- Transponder

1.4- Fuel management

The fuel tank order is : first the central tank (do not leave more than 25 gallons), then the wing tanks. No aerobatics with more than 1/3 of the central tank filled.

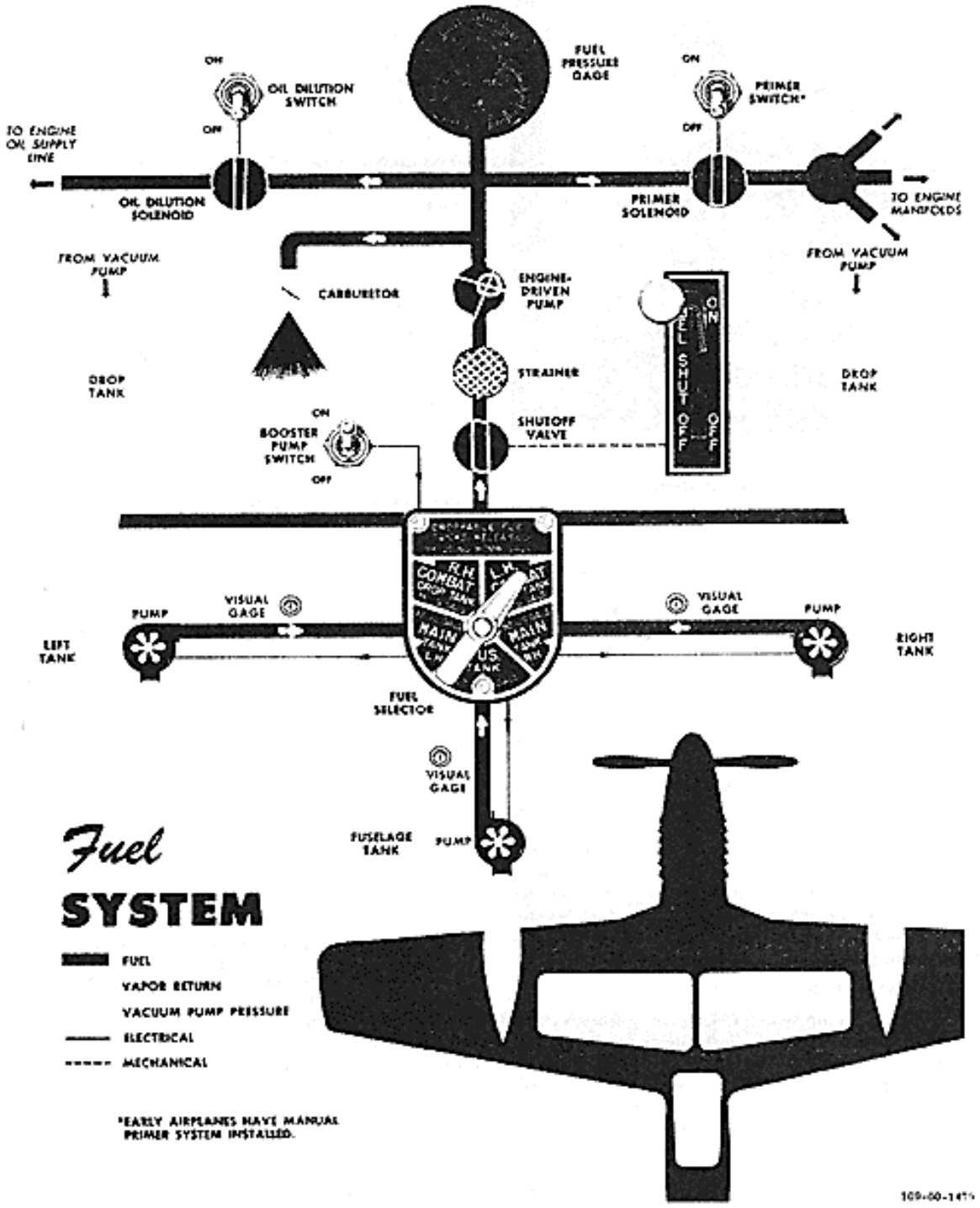


Figure 1-17

2- Specifications

2-1 Engine :

1*1100 kW Rolls Royce-Packard V- 1650- 7 Merlin

2-2 Propellor :

1 4-blade propeller Hamilton Standard Constant Speed (11ft, 2 inch)

2-3 Dimensions :

Length = 9.83 m
Wingspan = 11.28 m
Heigth = 4.16 m
Wheelbase = 3.874 m
Wing surface = 21.83 m2

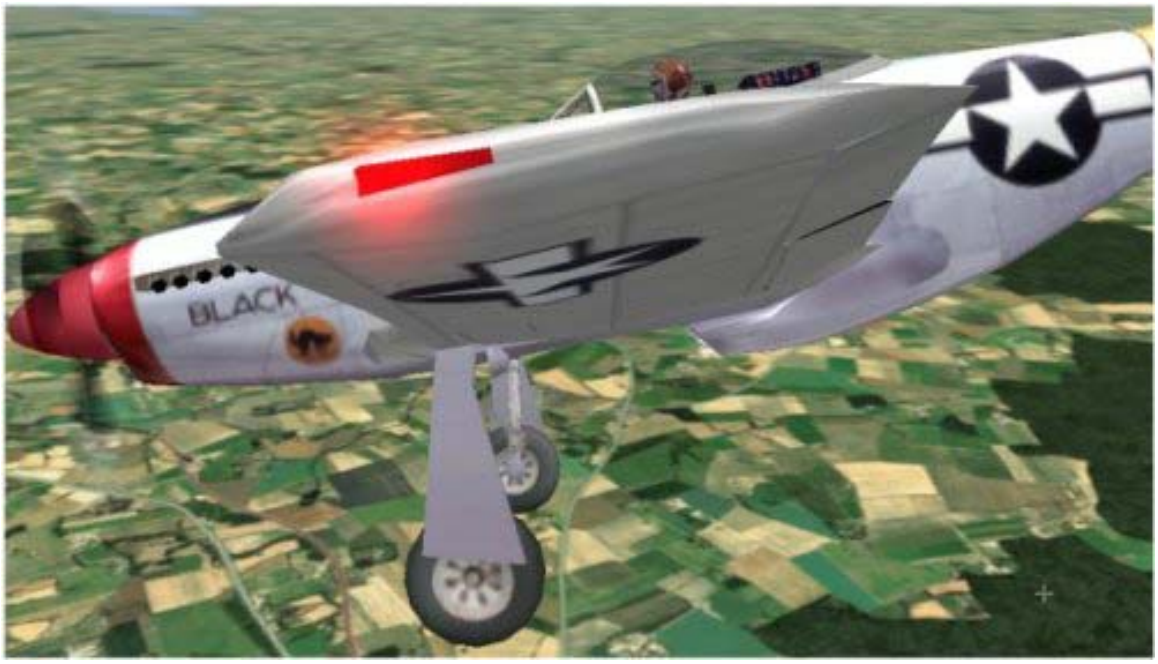
2-4 Weight (Model D) :

empty = 3466 kg
Max = 5493 kg

2-5 Divers

Ceiling = 42500 ft
Range = 3350 km
Max speed = 380 kts (505 mph, 703 km/h)

Armament = 6 x mg 12.7 mm 2 x b454 kg



3- Starting the engine

3.1 Pre-flight check

Make sure your aircraft is airworthy, check the tires, the moving parts, the lighting and the antennae.
Check the oil (level, quality), the level of the 3 fuel tanks (**beware : the right and left fuel tanks are inverted due to a bug of Fly! II**).

Setting the fuel levels in Fly!II

	NO.	USABLE FUEL IN LEVEL FLIGHT (EACH)	FULLY SERVICED (EACH)	EXPANSION SPACE (EACH)	TOTAL VOLUME (EACH)
LH MAIN	1	90.4	92.7	5.0	97.7
RH MAIN	1	90.0	92.1	4.5	96.6
FUSELAGE	1	65	65.5	26.0*	91.5
DROP TANKS	2	75.0	75.0	2.3	77.3
	OR				
	2	110.0	110.0	3.3	113.0

Gauge, fuel selector and capacities

Do not forget to set the parking brake.

3-2 Start up

a. Set the ignition selector to OFF (ignition).
b. Battery and generator switch to on ON.
c. « Radiator Air Control - OIL » switch AUTO
d. « Radiator Air Control - COOLANT » switch AUTO
e. Move throttle forwards about 3 cm (black lever)
f. Mixture control set to "IDLE CUT-OFF" (red lever at 0%).
g. Propellor control set to "100%" (Blue lever at 100%)
h. « Supercharger » switch set to "HIGH".
i. "RAM AIR" lever forwards(ON)
j. Set the ignition selector to BOTH
k. " Fuel shut-off " to ON
l. Fuel selector control to "Main tank LH" or, if empty, to the other wing tank
m. Fuel Booster to ON and check the pressure reaches the green zone
n. Move the PRIMER switch 3 seconds.
o. Lift the cover over the starter switch and move it to the START position
p. As soon as the engine fires, move the mixture control lever to RUN (100%)
q. If the engine doesn't start, move the PRIMER switch until it does.
r. As soon as the engine runs normally, switch off the starter
s. Swith "Generator" to ON

WARNING: When engine is not firing, mixture control should be set to IDLE CUT-OFF.

t. Let the engine warm-up at 1300 RPM. Check that the oil pressure remains constant . If there is no oil pressure or if it is too low, cut the engine (Mixture control lever)
u. Check all gauges.
v. Check the "Fairing door emergency level" is pushed and you have the good pressure (1000 psi) indicated on the gage under this level.
w. Check the hydraulics by moving the flaps
x. Set the radios.
y. Check gyroscopic instruments.
z. Check each fuel tank with the fuel pump set to ON The pressure should be at 14-19 lbs/sq. inch

You are ready for taxing, ask the tower for clearance.

3-3 Starting the avionics

ADF selector

1- The OFF switch the NDB only
2- Frequency display
3- A, B, C, D display selector

Transponder

For safety reasons, the plane has been equipped with a modern transponder.

9- ON/OFF NDB mode selector
10- Ident code display

Radio

The radio has 760 channels, only the stand-by frequency on the right can be modified with the channel selelector button. You move the frequency to active by pressing the white switch.

4- Active frequency
5- Standby frequency (tune-able)
6- Active/standby selector
7- Frequency knob (integer)
8- Frequency knob (decimal)
11- Radio ON/OFF switch

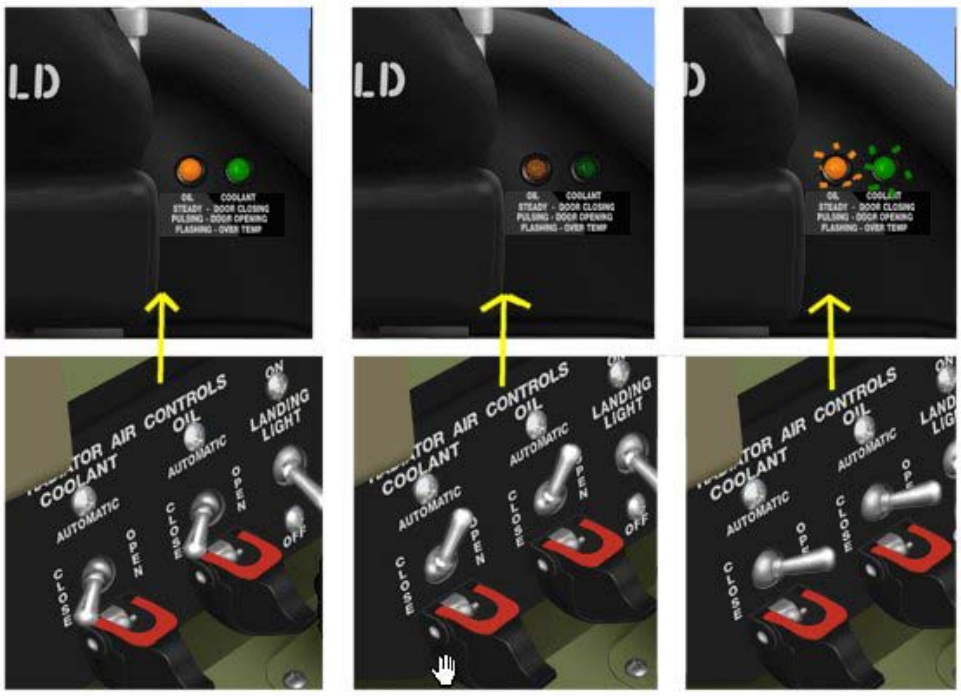
This aircraft has neither VOR, ILS or GPS (but you can display one (GPS) by using Fly!'s menu bar).

3.4 The artificial horizon

Switched ON automatically after the engine has started by rotating the knob at the lower right of the gauge. By increasing power, the “CAGED” flag will disappear and the horizon will become active.

3.5 The « SHUTTERS »

These 3-position switches allow to manage the engine cooling. These should be set according to the coolant and oil temperatures. Each position has a separate warning light situated on the right top of the panel. Set on “AUTOMATIC” after the engine has started. Quick flashes if overtemp.



4- Take-off

1. lower flaps (10° or 20°)
2. oil pressure in the green zone (75 lbs.)
3. oil temperature : mini 20° C, max 105° C
4. coolant temperature between 60° C and 121° C
5. fuel pressure in the green zone (FUELBOOSTER on ON)
6. At 2300 RPM, move prop pitch lever till prop RPM reduces to 2000 then move it back to INCREASE RPM 100%
7. Take-off :
   manifold pressure : 61 Hg
   RPM : 3000
   Mixture : RUN

5- Climbing and cruise

1. Climb

Manifold pressure = 45 Hg
RPM : 2700
Mixture : RUN

2. Cruise

Manifold pressure = 30-40 Hg
RPM : 2100-2300
Mixture : RUN

6- The approach

1. Mixture control on "RUN" (Red lever)
2. Oil and coolant radiator air controls on "AUTOMATIC"
3. Fuel selector on fullest tank
4. FUEL BOOSTER ON
5. Propellor control set for 2700 RPM
6. Lower landing gear below 170 MPH (check position of gear by the warning green lights)
7. Lower flaps f during approach. Do not exceed the following settings

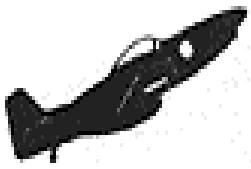
angle	vitesse max en MPH
10°	400
20°	275
30°	225
40°	180
50°	165

8- Minimum speed before the flare : 92 MPH

7- Speed limits

Stall Speeds IAS • MPH (POWER OFF)

BASED ON FLIGHT TESTS

	GROSS WEIGHT LB	GEAR UP FLAPS UP			GEAR DOWN FLAPS 45° DOWN		
		LEVEL	30° BANK	45° BANK	LEVEL	30° BANK	45° BANK
WITH WING RACKS							
	10,000	106	115	128	101	110	123
	9,000	101	109	121	94	103	116
	8,000	94	102	114	87	98	108
WITH BOMBS, DROP TANKS, OR ROCKETS*	12,000	119	128	143	113	123	136
	11,000	113	122	137	107	117	131
	10,000	108	116	130	102	111	124
	9,000	102	110	123	95	105	117

*STALL SPEEDS WITH ROCKETS ARE ESTIMATED.

109-60-1139

Figure 6-1

8. Specificities ROTW's P51 and important information

Fuel management :

we added this gauge for there only was a fuel pressure gauge in the plane we based ourselves on.

As fuel vapors are evacuated to the wing tanks, it is advised to start your flight on the central fuel tank.
In order to keep the plane properly balanced for landing, it is advised to leave at least 32 gallons of fuel in the central tank.

Engine management :

- When the manifold pressure is set between 42 and 61 inch, it is automatically maintained.
- Warning, after a long descent with a reduced throttle, the cylinder temperature may become too low and the engine may stall. In this case, increase the RPM.
- The P51 D was not designed for inverted flights lasting more than 10 seconds because of loss of oil pressure and failure of the scavenge pumps to operate in an inverted position. If engine coughs while inverted, resume normal flight and everything will return to normal after a few seconds.
- The airspeed indicator is in **miles per hour** (1 kts = 1.125 MPH).
- The FUEL BOOSTER switch must remain on ON during the entire flight.
- The real plane we based ours on is equipped with an automatic carburetor heating system. As this system could not be simulated in Fly!II, leave the CARB HEAT switch set to OFF during the entire flight (except if carb temperature goes under zero°C).

Cockpit lighting

Has not been simulated in this version.

Stalls

Stalls on this aircraft are comparatively mild with a tendency to roll to a side which can easily be recovered with the rudder. This behaviour has been carefully modelled.

Stall speeds

"clean" : 90 MPH (78 KTS),
gear and flaps down = 75 MPH (65 KTS)

Very important:

1- Temperature management

The engine temperature is managed by switch #11 (Coolant Radiator Air control) as shown in the manual

CLOSED setting

The engine cowl flaps are closed

OPEN setting

The engine cowl flaps are open

AUTOMATIC setting

The engine cowl flaps are automatically set according to the engine coolant temperature

Above 113°, the green coolant warning light starts to blink and the cowl flaps open automatically. The temperature increase rate is slowed down and will allow you to fly another 15 minutes at full power.

Below 97°, the cowl flaps close.

At 123° the engine stutters.

At 124° the engine breaks down .

To reduce the engine's temperature, the most effective way is to reduce RPM and Manifold pressure.

In a nutshell

COOLANT TEMP	EFFEct
<97°	Cowl flaps closed
>97°	Cowl flap open
123°	Engine stutters
124°	Engine dies

2- Carb temperature management

Managed by the combination of the RAM AIR and CARB HEATLEVERS.

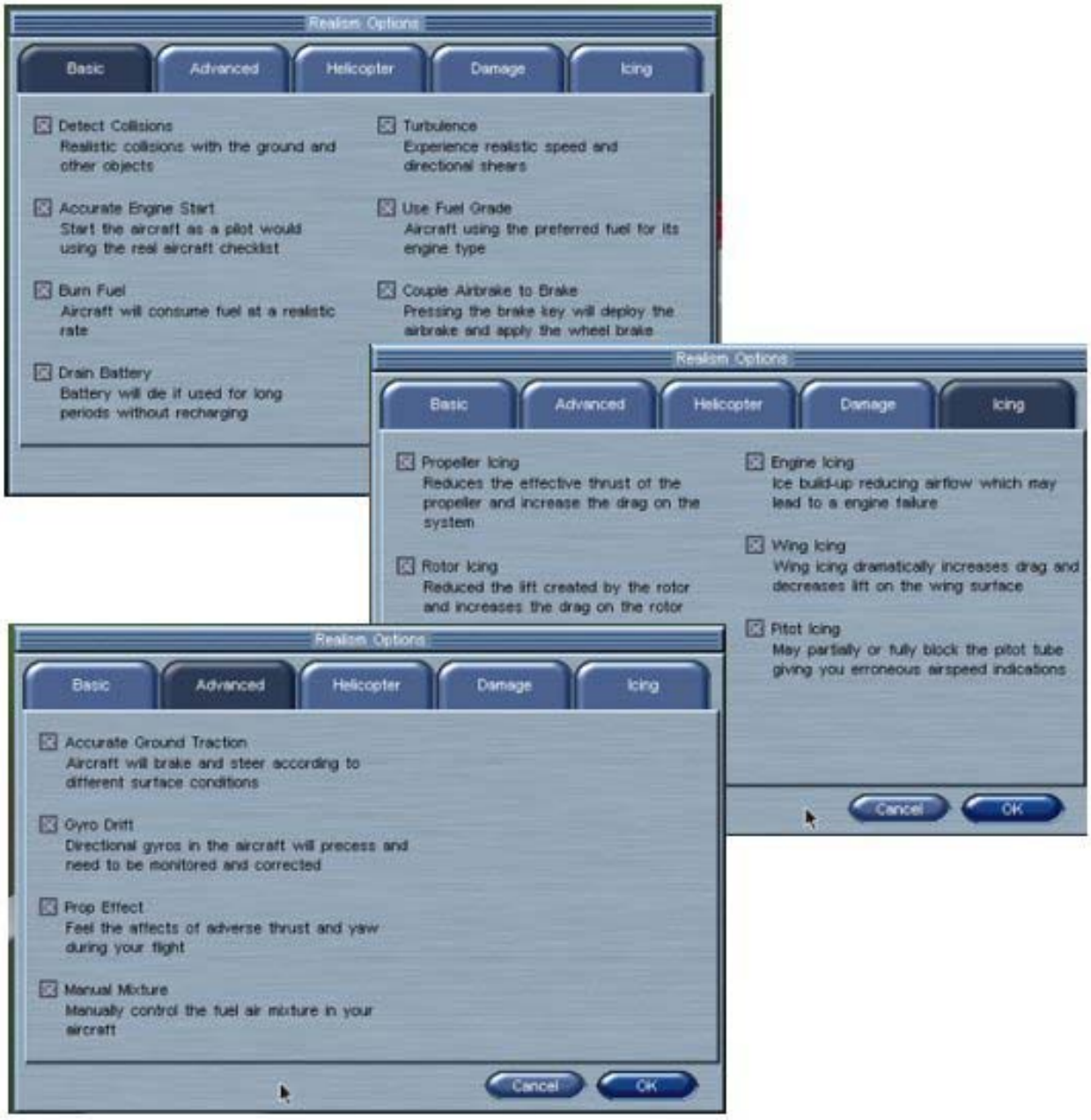
	RAM-AIR CLOSED	RAM-AIR OPEN
CARB HEAT CLOSED	Carb temp is based on engine temperature and in small measure on outside temperature	Carb temp based on the outside temperature
CARB HEAT OPEN	Additional heating from the engine	

The engine stutters outside the [-15,50] limits
The engine breaks when outside the[-16,52] limits

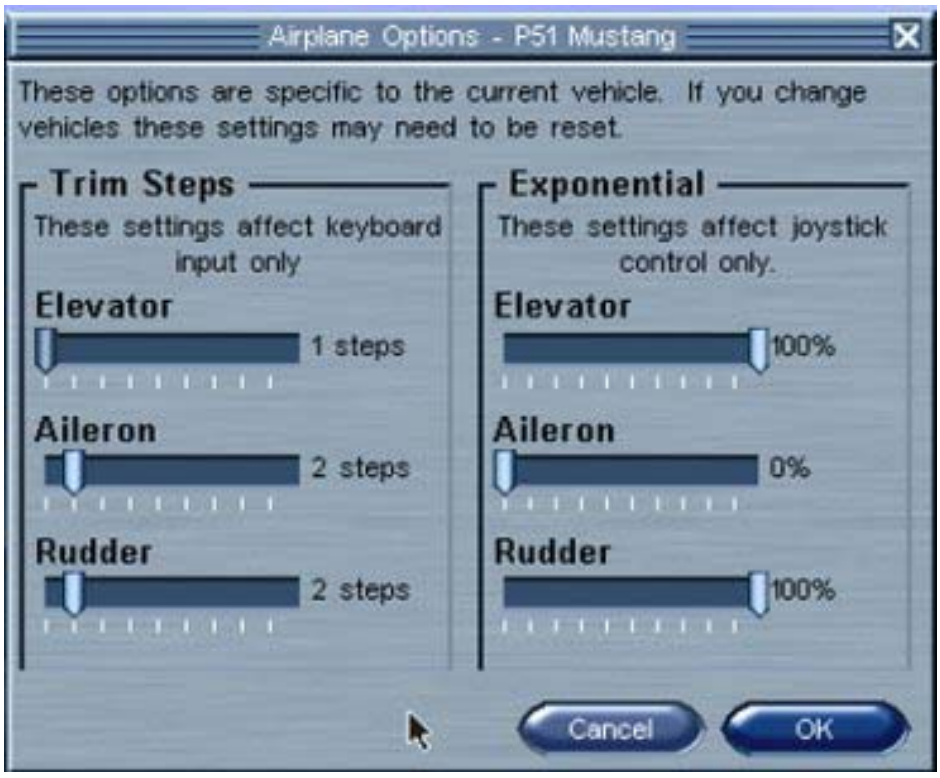
8.1 Simulator settings

Realism settings in Fly! II

In order to appreciate the plane to the fullest, the following



Aircraft Settings :
You MUST apply the following settings for the P51D



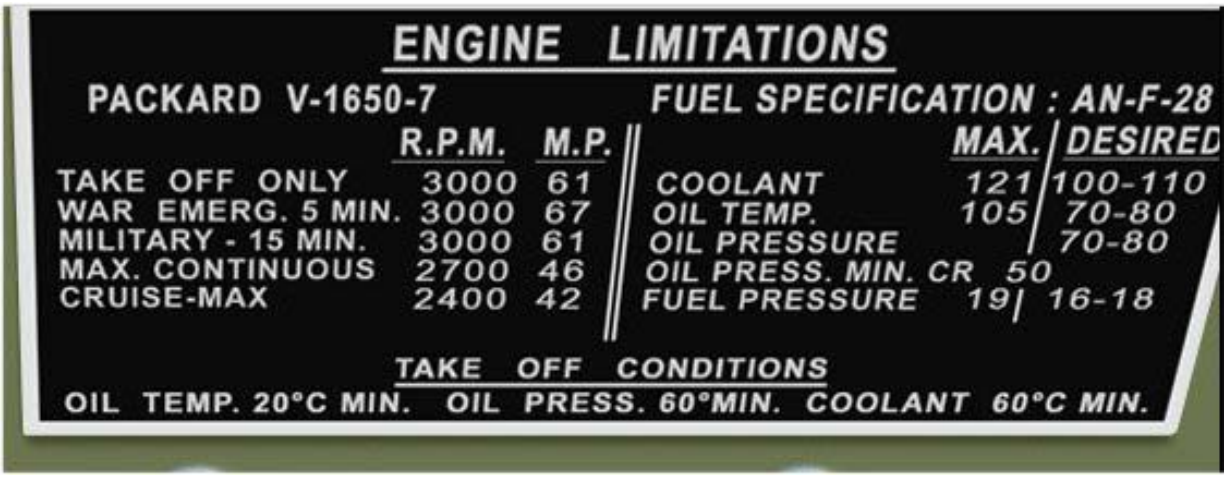
Suggestion : if possible, assign keys or joystick buttons to the following :

- prop pitch (blue lever)
- Mixture control (red lever)
- Trim

During critical phases of flight (i.e. approach) modifying their settings request selecting the view of the lower part of the panel which is not very safe. Shortcuts are better (and safer !).

8.2- Outside views from the cockpit

8.3 Keep in sight!



9 - The essential instruments

A short description of the main instruments of the P51 D

Oil temperature

Minimum	20°C
Normal	70°C - 80°C
Maximum	105°C

Oil pressure

Minimum	50 psi
Normal	70 - 80 psi

Fuel pressure

Minimum	16 psi
Normal	16 - 18 psi
Maximum	20 psi

Accelerometer

5G	max weight (10840 lb)
8G	8000 lb
-2.6G	max weight

Air-speed

Full flaps	165 mph max
Gear down	170 mph max
max IAS	505 mph (max structure)

Hydraulic pressure

800-1250 psi	normal (pressurised)
600 psi	min
1250 psi	max
0 - 150 psi	normal (non pressurised)

Suction

3.75 in.Hg	min
3.75 - 4.25 in.Hg	normal
4.25 in.Hg	max

Tachometer

1600 - 2700	continuous
2400	max cruise
2700	max continuous
3000	take off

Manifold

26 - 46 in. Hg.	Normal
61 in. Hg.	take off
67 in. Hg	War emergency 5 mn

Carburetor air temp

15°C à 40°C	normal
-10°C à -15°C	caution icing
50°C	Max

Coolant temperature

60°C	Min take off
100°C - 110°C	Normal
121°C	Max

10 – A few still-flying Mustangs

The Original Mustang chosen for the simulator

The Old Flying Machine's Mustang (Breitling Patrol)

Aeroretro's Mustang (Christian Mafré)

11 Credits

1 – The P51-D was built by North American in the USA. Among several versions, the D type had a bulged canopy for improved visibility.

2- Development for Fly!2 : « Rest Of The World » (ROTW)

a. Project manager :	Jean Sabatier
b. 3D conceptor:	Jean Sabatier
c. Internal views:	TJ
d. Panel design and programming	TJ
e. Flight model	Laurent Claudet
f. 3D animations	Jean Sabatier
g. 2D animations	TJ
h. Systems management	Laurent Claudet
i. Research	Jean Baruch
j. Flight preparation screens	René Birot
k. Real and virtual test flights	Christian Mafré (pilote reel Mustang) René ”Pacha” Birot Gilles »Doc Parano » Forel Jean-Paul Mes Yves Missenart Leen de Jager Johnny Svensson Nicolas Boltoukhine
l. Flight manual (F)	René Birot
m. English translation of the flight manual	Jean-Paul Mes
n. Cover page	Jean-Paul Mes

Many thanks to Mr Maurice Hammond for the internal real pictures, to Ms Laura J. Wetton, Operations Manager at the Old Flying Machine Company Ltd. for taking the time to answer our questions and to Jean-Pierre Bougeois for his high level cooperation.

The drawings used on the cover page and some illustrations used in this manual were extracted from an original 1947 P51 manual .