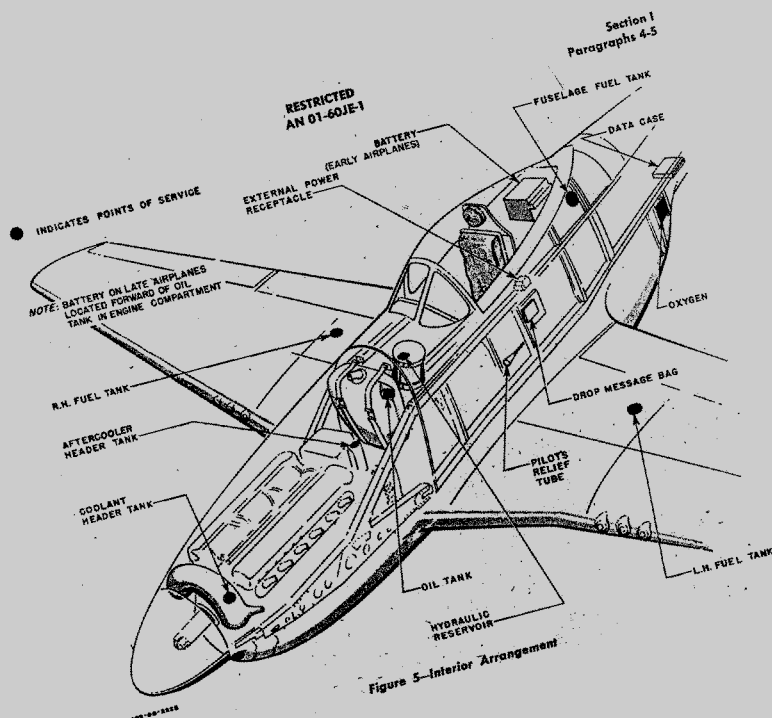
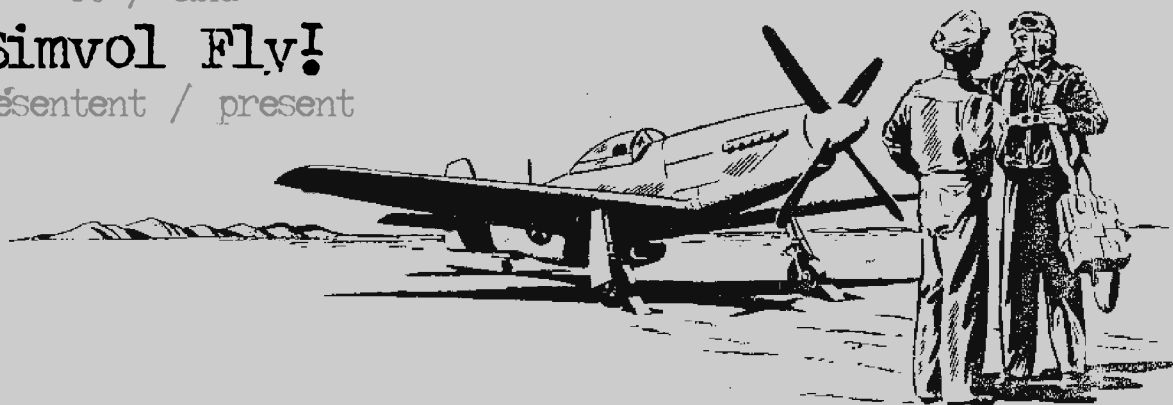
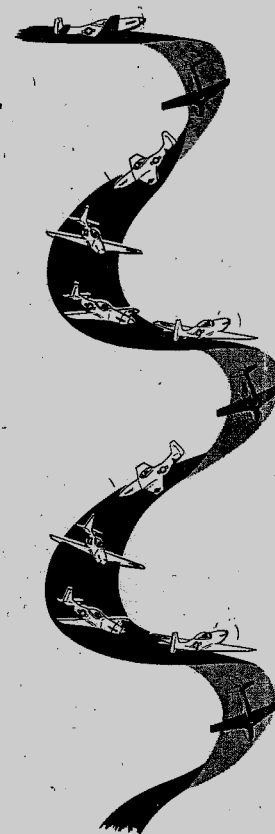


ROTW
 French Developers Team
 et / and
 Simvol Fly!
 présentent / present



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

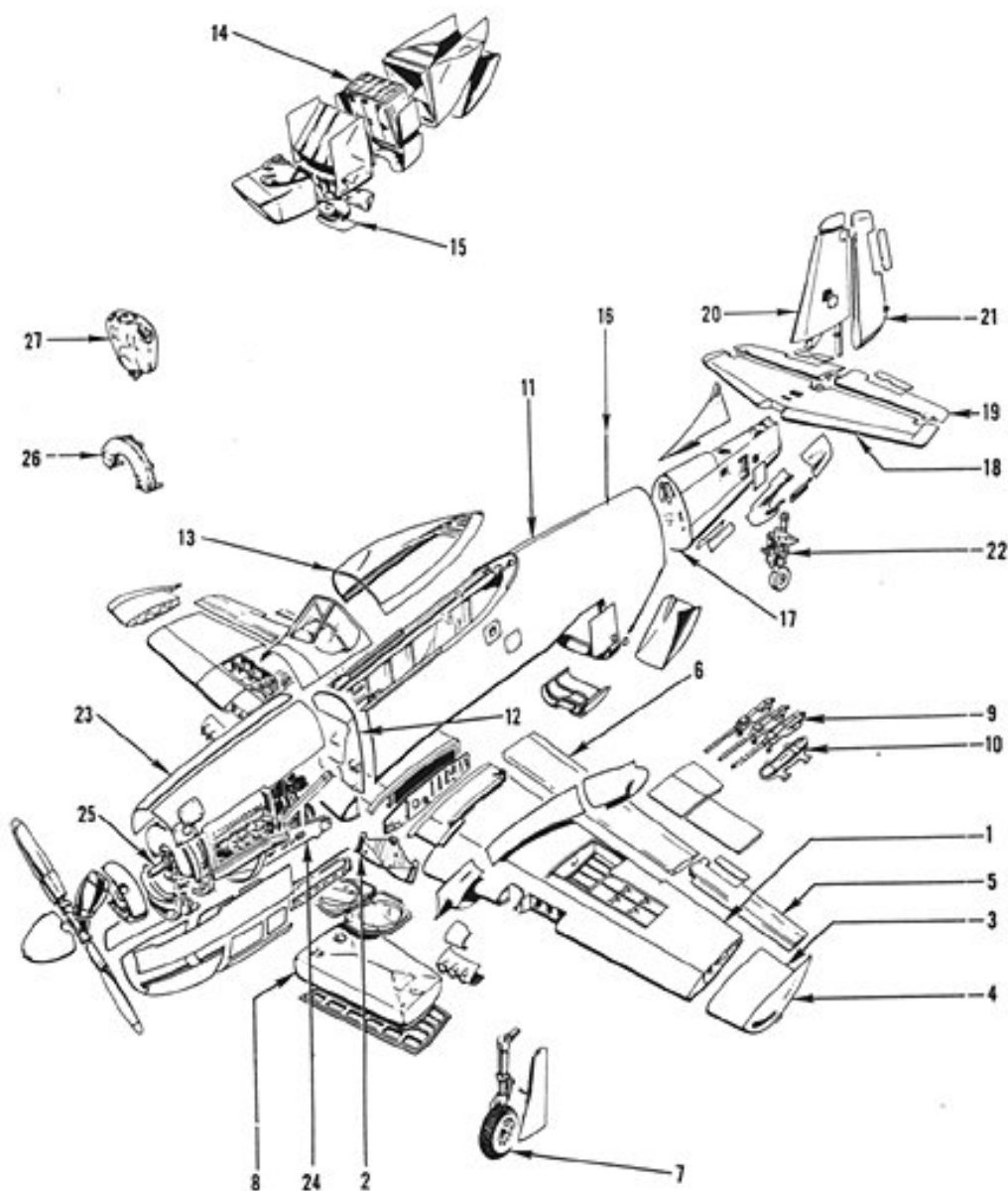
1. Guided visit of the P51D Mustang for Fly !
 - 1.1. Outside view
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 - 1.3. The instruments
 - 1.3.1. The main panel
 - 1.3.2. The lower panel
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10. Pictures of still-flying Mustangs
11. Credits

Observations :

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



- 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.

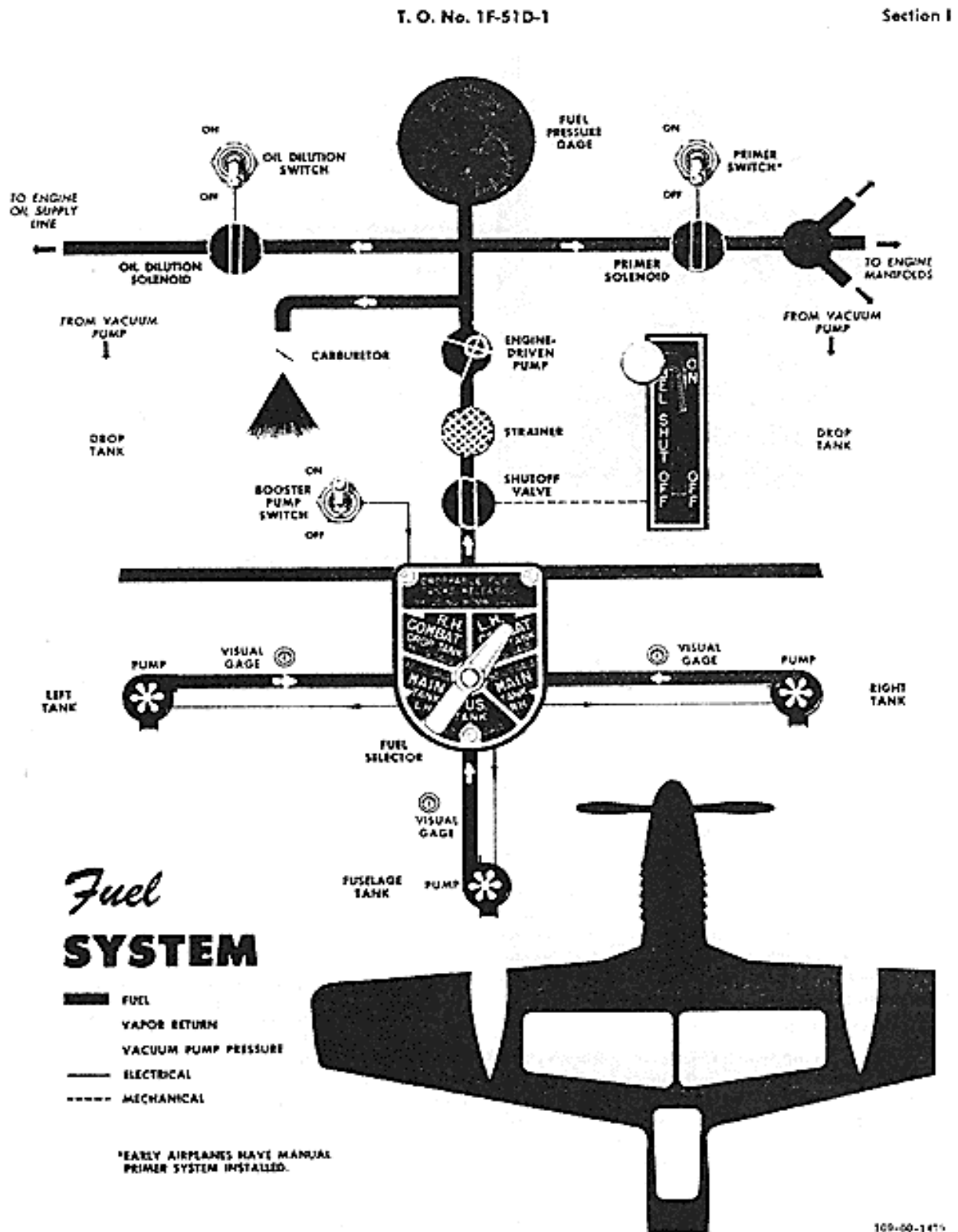


Figure 1-17

2- Specifications

2-1 Engine :

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

2-2 Propellor :

1 4-blade propellor

2-3 Dimensions :

Length = 9.83 m

Wingspan = 11.28 m

Height = 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*mg 12.7 mm 2*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 ON LEVEL FLIGHT (GAL)	FUEL SERVICE (GAL)	EXPAUSION SPACE (GAL)	TOTAL VOLUME (GAL)
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.
- 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 "AUTO" (automatic).
- 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

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

- s. 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)
- t. Check all gauges.
- u. Check the hydraulics by moving the flaps
- v. Set the radios.
- w. Check gyroscopic instruments.
- x. 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 cuts all radios
- 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 ADF 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 selector 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)

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

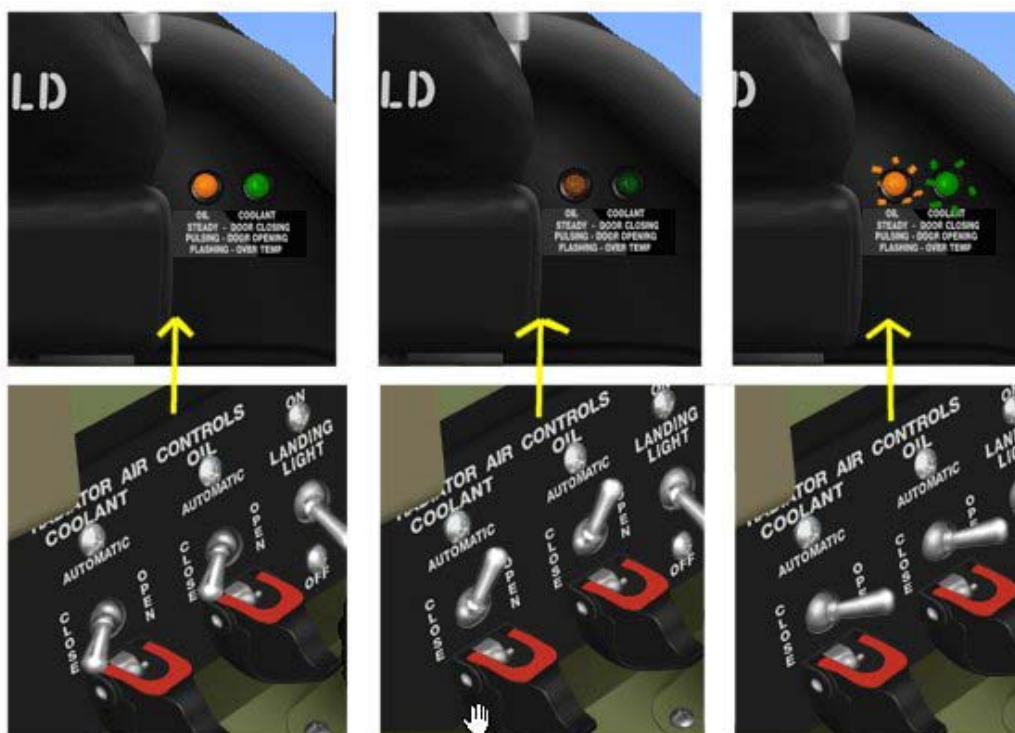
3.4 The artificial horizon

Must be switched on manually 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 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.



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 : 40 Hg
RPM : 3000
Mixture : RUN

5- Climbing and cruise

1. Climb
Manifold pressure = 35 Hg
RPM : 2600
Mixture : RUN
2. Cruise
Manifold pressure = 26-28 Hg
RPM : 2300-2400
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- Speed before the flare : 92 MPH. Beware not to reduce too much for the engine might stall

7- Speed limits

Stall Speeds

IAS • MPH

(POWER OFF)

BASED ON FLIGHT TESTS

WITH WING RACKS

GROSS
WEIGHT
LBGEAR UP
FLAPS UPGEAR DOWN
FLAPS 45° DOWN

LEVEL

30° BANK

45° BANK

LEVEL

30° BANK

45° BANK

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.

109-30-1139

Figure 6-1

4. 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!!!, 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

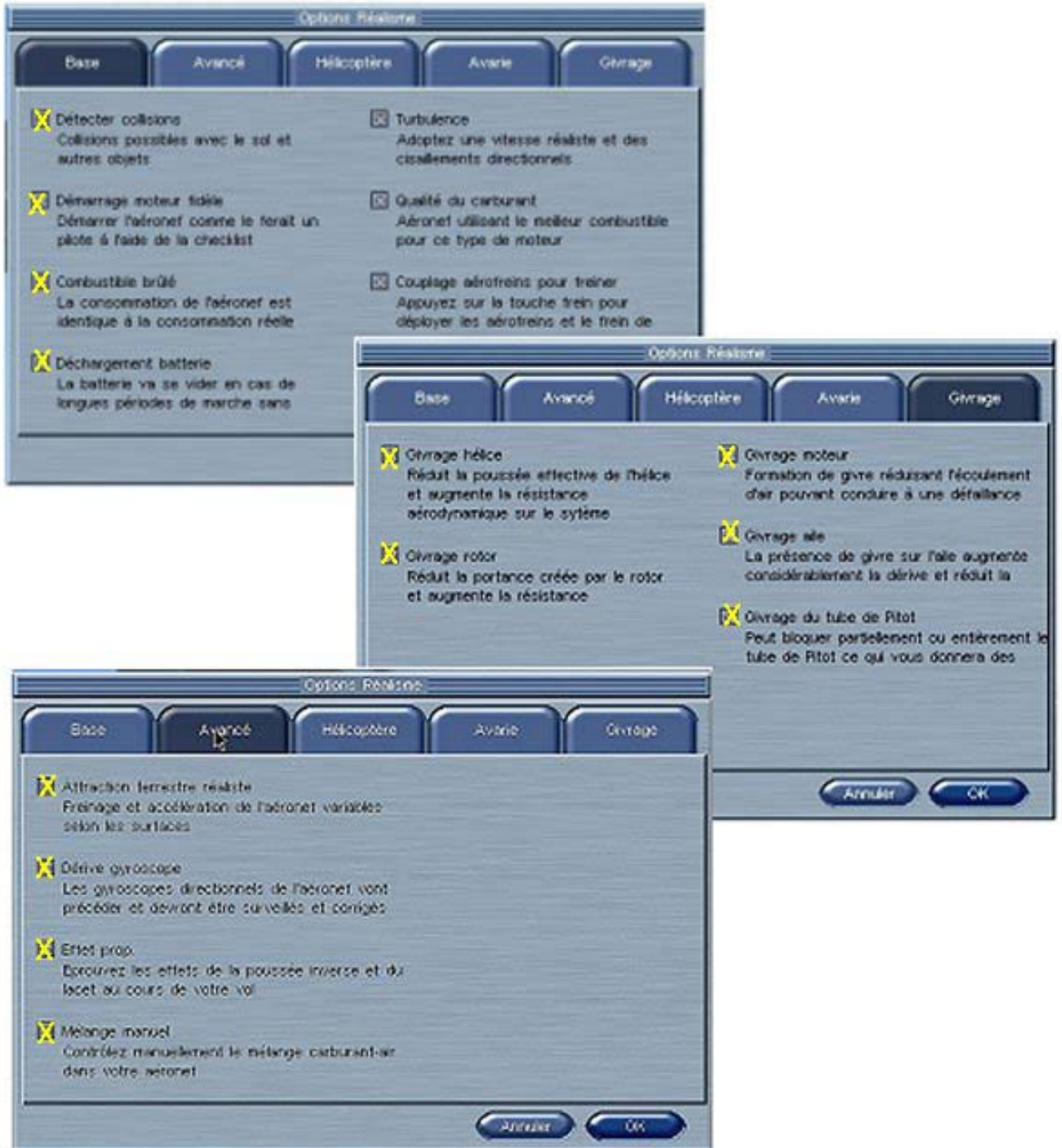
Stalls on this aircraft are comparatively mild with a tendency to roll to a side which can easily be recovered with the rudder. This behaviour has been carefully modelled.

Stall speeds : “clean” : 90 MPH (78 KTS), gear and flaps down = 75 MPH (65 KTS)

4.1 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!

ENGINE LIMITATIONS				
PACKARD V-1650-7			FUEL SPECIFICATION : AN-F-28	
	R.P.M.	M.P.	MAX.	DESIRED
TAKE OFF ONLY	3000	61	COOLANT	121 / 100-110
WAR EMERG. 5 MIN.	3000	67	OIL TEMP.	105 / 70-80
MILITARY - 15 MIN.	3000	61	OIL PRESSURE	70-80
MAX. CONTINUOUS	2700	46	OIL PRESS. MIN. CR	50
CRUISE-MAX	2400	42	FUEL PRESSURE	19 / 16-18
TAKE OFF CONDITIONS				
OIL TEMP. 20°C MIN. OIL PRESS. 60°MIN. COOLANT 60°C MIN.				

MAX. GLIDE OR DIVE SPEED	
SURFACE TO 10.000 FT	- 505 MPH
10.000 TO 20.000 FT	- 400 MPH
20.000 TO 30.000 FT	- 325 MPH
GEAR - FLAPS	
DO NOT EXTEND FULL FLAPS ABOVE 165 MPH	
DO NOT OPERATE LANDING GEAR ABOVE 170 MPH	



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 used 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 concepthor:	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 (Aérorétro) René Birot, Gilles Forel, Jean-Paul Mes (ROTW)
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 and to Ms Laura J. Wetton, Operations Manager at the Old Flying Machine Company Ltd. Imperial War Museum - Duxford Airfield – England for taking the time to answer our questions.

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



Legal information: This plane should not be modified without the consent of its conceptors