ULPOWER
AERO ENGINES

UL260
UL350
UL390
UL520

Operating Manual

Preface

Thank you for choosing ULPower Aero Engines to power your aircraft.

This manual will provide you with basic information on safe engine operations / safe flights.

We recommend to study this manual carefully, before starting the engine for the first time.

If you are unsure about the procedures mentioned in this manual, please contact a ULPower authorised sales or service point.

We hope you will enjoy flying your ULPower-ed aircraft.

Remarks

The diagrams and other pictures in this manual show the typical construction. They may not represent in full detail or the exact shape of the parts which have the same or similar function.

Specifications are given in the SI metric system with the USA (Imperial system) equivalent in parenthesis. Where precise accuracy is not required, some conversions are rounded off for easier use.

In addition to this Operating Manual, please refer to the following:
- Installation Manual
- Technical Data
- Installation checklist
- Trouble shooting manual
- Illustrated Parts Catalogue
- Propeller flanges documentation
- Maintenance Manual

Please make sure you have the latest version available of the applicable manual.

Modifications

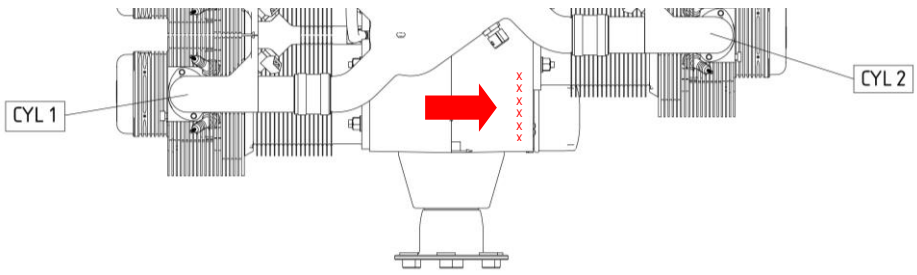
The information and components/system descriptions contained in this Operating Manual are correct at the time of publication. ULPower, however, maintains a policy of continuous improvement of its products without imposing upon itself any obligation to install them on its products previously manufactured.

ULPower reserves the right at any time to discontinue or change specifications, designs, features, models or equipment without incurring obligation.

Please contact your dealer or check the manufacturers website (www.ULPower.com) for any updates or changes concerning the engine and its manuals.

Engine serial number

On all enquiries or spare parts orders, always indicate the engine serial number. The serial number (6 digits) can be found on top of the engine near to cylinder 2.



Repeating symbols

This manual uses the following symbols to emphasize particular information. These indications are important and must be respected.

✖ **WARNING** : Identifies an instruction which, if not followed, may cause serious injury including the possibility of death.

★ ***Attention*** : Denotes an instruction which, if not followed, may severely damage the engine or other components.

Note : Indicates supplementary information which may be needed to fully complete or understand an instruction.

Safety information

- The engine should only be installed and operated by persons familiar with the use of the engine and informed with regard to possible hazards.
- Familiarize yourself with the installation, maintenance and operational limits of your ULPower engine. Failure to follow the instructions in these manuals can result in a serious malfunction or loss of power in flight, with possible loss of life, injury or damage to the equipment. Limit yourself to the operations/ maintenance mentioned in ULPower manuals. If you are uncertain and/or in need of extra information please contact a ULPower authorized sales or service centre.
- This non-certified engine is designed for possible application on aircraft used in VFR conditions which have the capabilities of controlled gliding without engine power.
- You should be aware that any engine may malfunction at any time. This could lead to a crash landing and possible severe injury or even death. For this reason, we recommend strict compliance with the maintenance and operation manuals and any additional information which may be given to you by your authorized sales or service centre.
- Never fly the aircraft equipped with this engine at locations, airspeeds, altitudes, or other circumstances from which a successful no-power landing cannot be made, after sudden engine stoppage.
- Make sure you know what engine you are using. Only engines UL260iSA /UL350iSA/ UL390iSA/UL520iSA are suited for acrobatics (inverted flight, etc.).
- It should be clear that the choice, selection and use of this particular engine on any aircraft is at the sole discretion and responsibility of the aircraft manufacturer, assembler and owner/user. ULPower makes no warranty or representation on the suitability of its engine's use on any particular aircraft. Furthermore, ULPower makes no warranty or representation of this engine's suitability with any other part, component or system which may be selected by the aircraft manufacturer, assembler or user for aircraft application.
- Never (test) run the engine without a propeller or flywheel as this will inevitably cause engine damage and present a hazard of explosion.
- Propeller/flywheel and its attachment with a moment of inertia in excess of the specified value must not be used and releases engine manufacturer from any liability.
- Improper engine installation and use of unsuitable piping for fuel-, cooling-, lubricating -, intake and exhaust system releases engine manufacturer from any liability.
- Unauthorized modifications of engine, its components, ECU, etc. will automatically exclude any liability of the manufacturer for direct, indirect and/or consequential damage.
- Spare parts must meet with the requirements defined by the engine manufacturer. This is only warranted by use of genuine ULPower spare parts and/or accessories. They are available at the authorized ULPower distribution- and service partners.
- The use of anything other than genuine ULPower spare parts and/or accessories will render any warranty relating to this engine null and void.
- Respect all government or local rules pertaining to flight operation in your flying area. Fly only when and where conditions, topography, and airspeeds are safe.
- Select and use proper and calibrated aircraft instrumentation. This instrumentation is not included with the basic ULPower engine.
- Before flight, ensure that all engine controls are operational and engine is airworthy. Make sure all controls can be reached in case of an emergency.

- Unless in a run up area, never run the engine with the propeller turning while on the ground. Do not operate engine if bystanders are close.
- In the interest of safety, the aircraft must not be left unattended while the engine is running.
- Keep an engine log and respect engine and aircraft maintenance schedules. Keep the engine in top operating condition at all times. Do not operate any aircraft which is not properly maintained or has engine operating irregularities which have not been corrected.
- To eliminate possible injury or damage, ensure any loose equipment or tools are properly secured before starting the engine.
- When in storage protect the engine, fuel, lubrication, induction and exhaust system from contamination and exposure.
- Never operate the engine without sufficient quantities of lubricating oil, fuel and cooling air.
- Allow the engine to cool at idle for several minutes before turning off the engine.

Table of contents

Description of systems

Lubricant system

The high-volume oil pump, with integrated pressure release valve, takes up oil through a coarse filter on the oil pick up tube which is located in the wet oil sump.

An impressive amount of pressurized oil is pumped through the mandatory oil cooler (not included as standard with the engine) and oil filter before it enters the main oil gallery where it lubricates the essential parts of the engine. Excessive oil accumulates back into the oil sump.

Fuel system

Fuel from the tanks is guided through a coarse filter before reaching the electrical fuel pump. This high-volume fuel pump (>=120l/h or >=32USgal/h) creates a pressurized fuel flow and pumps fuel through a fuel fine filter towards the injectors and the integrated fuel pressure regulator. Afterwards excessive fuel is returned to the fuel tank.

Electronic Engine Management system

All ULPower engines are equipped with an electronic injection and ignition system.

The ECU automatically sets the fuel mixture and ignition timing (multiple times per second!). As a result, in the cockpit, there is no choke, no primer, no carb heat, and no mixture, just a single lever: the throttle. It will even fine tune the fuel flow to compensate for changes in barometric pressure as well as inlet air temperature in the inlet manifold/airbox. The fuel mixture and ignition timing are controlled for operations up to 18.000 ft.

With timing corrections to avoid detonation and a built-in rev-limiter, (3.300rpm on most naturally aspirated engines or 2.700 RPM on turbo engines) the ECU not only ensures efficient power to fuel consumption at any given operating condition.

Note: *The engine is managed electronically, consequently, the engine cannot run without a working electrical system.*
The UL 260 / UL350 engine and fuel pump use maximum continuous 15 Amps[1] to operate.
The UL 390 / UL520 engine and fuel pump use maximum continuous 21 Amps[1] to operate.

Note: *The UL260/UL350 engine comes standard with an integrated AC generator with external rectifier/regulator that can supply up to 30 Amps. The UL390/UL520 generator can supply up to 50 Amps. This should be sufficient to charge the battery while the standard engine is operating and other electrical aircraft systems are in use. Electrical system should be monitored to ensure sufficient electrical power is available to maintain battery charge at all times. In the event of alternator failure, in cockpit non-essential electrical systems should be switched off to maximize engine operation time whilst seeking an immediate landing site.*

Cooling system

All engines are air and oil cooled. Installing the ram air ducts that come with the engine, is mandatory. See installation manual for more info on this subject.

The installation of an oil cooler is mandatory as the oil is not only used to lubricate but also to cool the engine. See installation manual for more info on this subject.

[1] Operation: one pump, dual ignition, single ECU, 3300 RPM ,13.5V

Warning lights

The ECU provides output for two standard warning lights: (engine) check light and Battery low (<12.7 volts) light.

Note: *It is very important that your check light and battery low light is installed in accordance with the installation manual.*

Check light

Note: *The check light can be tested by switching power "ON" to the ECU: If installed correctly the check light will come up for 2 seconds (only for engines with a serial number higher than 191401). You can do an additional test by disconnecting one of the sensors; if the installation is ok, the check light will come up.*

When there is a problem with one of the following sensors, the CHECK light will come on

- Oil temperature sensor
- Inlet air temperature sensor
- Throttle position sensor
- Altitude sensor (nat. aspirated engines) or Turbo pressure sensor (Integrated in ECU)
- Hall sensor engine start (Sync/CPS)

★ ***Attention:*** In the above events the engine will continue to run when the check light comes on, however, it may not be running optimally due to the use of default values in the ECU-map. This might increase the fuel burn. Continue the flight and resolve the issue before next flight.

✖ **WARNING**: *Only valid for turbocharged engines* :

a. If the check light flashes, the overboost limiter is activated. The power output of the engine is strongly reduced. Reducing the throttle will deactivate the overboost limiter. Important to land as soon as possible.

b. If the check light is (steady) on AND the indicated boost pressure (on instruments) equals ambient pressure[2], than the engine power output will be slightly reduced (10-20%) and the fuel burn might increase. Continue the flight and resolve the issue before next flight.

Battery low

If the voltage at the ECU drops below 12.7 volts, the 'Battery low' LED will come on. It will disappear again when 13.0 V is reached.

[2] This indicates that the ECU is not measuring the correct pressure, see throubleshooting manual

General operating limits

Running in

a) <u>All engines</u>

- No need to use special run-in oil.
- To run in a new engine: It is important that the engine runs as much as possible at **operation temperature** (Oil temperature 80 to 110°C (176-212°F), CHT 110 to 140°C (230-284°F) and at **± 80% of the max. power** during the **first 15 hours.**
  This means: For the first 15 hours: avoid continuous running at full power. But on the other hand, do not run the engine for a long time at idle on the ground. Go flying: after take-off and initial climb (full power) reduce the power to approximately 80%.

Note: ***AS A GUIDELINE****: The power output can be checked in several ways:*

- ***EFIS/ULRead****: Read out ± 72% throttle position = ± 80 % Power output*
- ***Throttle level****: (linear 0-100%) = ± 80% throttle position = ± 80 % Power output*
- ***Manifold pressure:***
  - ***Naturally aspirated****: ± 80-85 kPa (± 23.6-25.1 inHg) = ± 80% Power output*
  - ***Turbo****: ± 105-110 kPa (± 31-32 inHg) = ± 80% Power output*

b) <u>Aerobatic engine</u>[3]

- Don't fly any aerobatic manoeuvres during the first 15 flying hours
- Follow the maintenance manual and add one bottle of ULP Acro + oil additive (ULP Part no. L0100120) every oil change starting from the first 15 hours oil change.

Performance (in ISA - International standard atmosphere - conditions)

Engine	Maximum peak HP *(for 5 minutes)*	Maximum continuous HP	Fixed pitch prop. Maximum continuous RPM[4]	VP/CS-prop. Maximum continuous MAP Indicated Manifold Air Pressure -bar [inHg]	Maximum RPM
UL 260i	97	87	2800	0.88 [26]	3300
UL 260iS(a)	107	95	2800	0.88 [26]	3300
UL 350i	118	112	2800	0.88 [26]	3300
UL 350iS(a)	130	123	2800	0.88 [26]	3300
UL 350iHPS	150	131	3000	0.88 [26]	3500
UL 390i	140	125	2800	0.91 [27]	3300
UL 390iS(a)	160	143	2800	0.91 [27]	3300
UL 520i	180	170	2800	0.91 [27]	3300
UL 520iS(a)	200	180	2800	0.91 [27]	3300
UL 520T	220	200	2700	1.22 [36]	2700

Table 1 : Performance

[3] Only available for naturally aspirated engines

[4] Rule of thumb in case of using a fixed pitch propeller. <u>When the max. WOT rpm is around 3000 -3100</u> (take-off RPM), the maximum take-off power (see 'Table 1: Performance') is permitted during a time period of **max. 5 minutes**, after this period, power must be reduced to <u>maximum continues HP ~ 2800 RPM</u>.

RPM

	Naturally aspirated engine	Turbo engine
	RPM	**RPM**
Maximum	3300 (3500 iHPS)	2700
Recommended cruise	2200-2800	2200-2500
Recommended idle speed	850	850
Min. idle speed	700	700
Requirements about RPM settings		
Min. static at WOT[5]	2550	2400
Min. take OFF at WOT	2800	2500
Min. WOT straight and level	2900	2600

Idle speed

The minimum recommended idle speed is 850 rpm. Typical idle speed is between 850 and 1000 rpm. For specific applications idle may, exceptionally, be reduced to 700 rpm provided vibration is not excessive on the installation. Idle values are WARM idle. Always ensure the engine is warm before setting your idle values. That is once the engine has reached an oil temperature of 50°C (122°F) or above. Avoid unnecessarily low idle speeds and vibrations.

Normal operation

Normal operation rpm depends on the application, but is typical :

- 2200-3000 for aeroplanes
- 2900-3200 for helicopters
- 2200-2700 using the turbo engine(s)

Maximum rpm/overspeed

The engines have an ECU RPM limiter set to the maximum RPM listed in Table 1: performance.

Acceleration

Only operate the engine at zero gravity and in negative "g" conditions during a limited amount of time. Positive oil pressure must be maintained at all times.

Deviation from bank angle[6]

Value to which the wet sump (normal oil level) lubrication system warrants lubrication in positive "g" flight situation
Max. ..... **35° (non-aerobatic engines).**

Altitude

The 3-dimensional fuel map controls the mixture and timing from start-up to shut-down.

- All naturally aspirated engines : -3 000 ft to 18 000 ft density altitude
- Turbo engines : -3 000 ft to 27 000 ft density altitude
- On request: up to 30 000 ft density altitude

[5] WOT: Wide Open Throttle

[6] In a stable climb or descent of X degrees (linear and non-parabolic), the deviation of bank angle (DBA) equals the angle (X) of the aircraft to the ground. In a controlled turn (1G) of X degrees, the deviation of bank angle will be 0°. More information can be found on ULPower.news

Operation limits

The operational limits for naturally aspirated and turbocharged engines are the same, with the exception of manifold air temperature (and turbo pressure).

Value	Volts V *	Oil Temp C / F	Manifold Air Temperature Naturally aspirated C / F **	Manifold Air Temperature Turbo C / F **	Fuel Pressure (rail sensor) Bar / PSI ***	Throttle position (%) ****	Oil Pressure Bar / PSI +	EGT C / F ++	CHT C / F +++	Outside Air Temperature C/F	Turbo pressure Bar/PSI ++++ Turbo	ECU (Ambient) Temperature C/F
Min: Red	12.5V	50°C 122°F	-30°C -13°F	-30°C -13°F	2.4Bar 35PSI	<5	0.7 – 1Bar 10 – 15PSI	300°C 573°F		-25°C -13°F	++++	-40°C -40°F
Yellow	12.5 – 12.7V	50 – 80°C 122 176°F				5-12	1 – 2Bar 15 – 29PSI	300 – 400°C 572 – 752°F	<50°C <122°F		++++	
Green	12.7 – 14.5V	80 – 110°C 176 – 230°F	-30 – 40°C -13 – 104°F	-30 – 60°C -13 – 140°F	2.4 – 3.4Bar 35 – 49PSI	12-95	2 – 5Bar 29 – 73PSI	400 – 850°C 752 – 1562°F	50 – 140°C 122 – 302°F	-25 – 50°C -13 – 122°F	1.32-1.38Bar 19.1 – 20.0PSI	-40 – 65°C -40°F – 149°F
Yellow	14.5 – 15.5V	110 – 120°C 230 – 248°F	40 – 60°C 104 – 140°F	60 –75°C 140 – 167°F	3.4 – 3.8Bar 49 – 55PSI		5 – 8Bar 73 – 116PSI	850 – 880°C 1562 – 1616°F	140 – 160°C 302 – 338°F		1.38-1.40Bar 20.0 – 20.3PSI	
Max: Red	15.5V	120°C 248°F	60°C 140°F	75°C 167°F	3.8Bar 55PSI	>95	8Bar 116PSI	880°C 1616°F	160°C 338°F	50°C 122°F	1.40Bar 20.3PSI	65°C 149°F

Note: *In dual ECU setups, the oil temp. reading will differ between the 2 ECU's. This is due to the placement of the oil temp. sensors. During normal operation, the temperatures should not deviate more than 15°C (~60°F) from each other.*

✖ **WARNING:** Make sure operating limits are respected at all times. Running the engine outside of the limits set by the manufacturer may severely damage the engine and will render any warranty relating to this engine null and void.

* Electrical power

Make sure the battery is **fully charged before take-off** (engine not running) with an output voltage min = 12.7 VDC. When the engine is running, the (alternator) voltage must be at least 13V.
When the 'battery low' warning light (see above) is activated during flight (indication alternator/regulator failure), the flight time with a full battery is ≥30 min[7]. Land as soon as possible. At around 10V the ECU stops functioning and the engine stops.

★ ***Attention***: Never use a "booster" (quick battery charger) to start the engine. Change the battery to avoid jump starting.

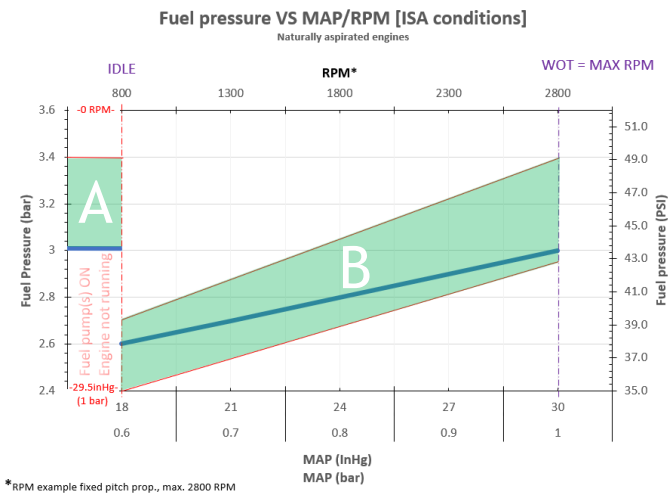
** Manifold air temperature

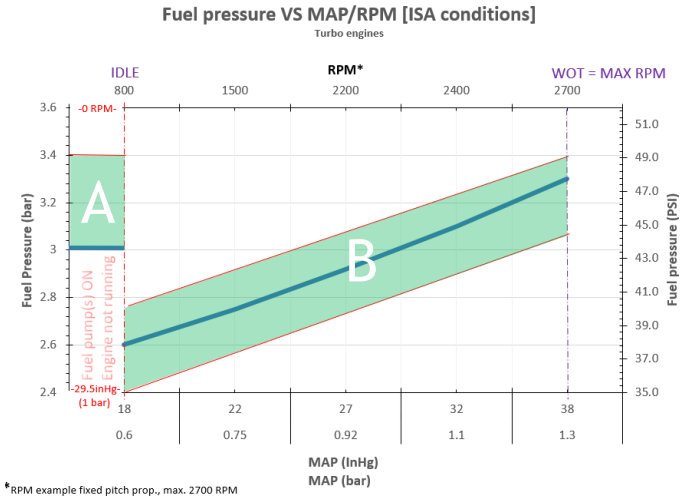
Note: *We advise to bring fresh air from outside the cowling to the inlet air filter/manifold. For turbo engines, we advise to install a suitable intercooler (see installation manual).*

Engine	Naturally aspirated	Turbocharged/normalized
Max. at start	60°C (140°F)[8]	70°C(158°F)
Max. at take-off	50°C (122°F) [5]	65°C (149°F)
Max. in flight	40°C (104°F)[5]	60°C (140°F)

*** Rail fuel pressure

Rail fuel pressure is the difference or delta pressure ABOVE the Manifold Air Pressure (M.A.P. may be measured by optional sensor)





	Condition	Remarks
A	ECU ON, Engine OFF, Fuel pump(s) ON	Fuel pressure (FP) 3 – 3.4 bar (43.5 – 49 PSI) Fuel pressure must be stable
B	ECU ON, Engine ON, Fuel pump(s) ON	FP depends on MAP/Throttle position Blue line ideal FP Idle ±2.6 bar (37.7 PSI) WOT ±3.0 bar (43.5 PSI) **nat. asp. engines** WOT ±3.3 bar (48 PSI) **turbo engines**

NOTE: Fuel pressure can be higher when using both fuel pumps.

[7] Fully charged healthy battery. Depending on installation, used battery/batteries, aircraft electrical system….
[8] Rule of thumb: ambient temperature + 10°C, with respect to maximum manifold air temperatures

****Throttle position

The throttle position, transmitted via CANbus or RS232, is a direct copy of the data from the throttle position sensor.

- **Sensor fault detection:**
  Values below 5% or above 95% indicate a possible sensor malfunction or wiring issue.

- **Typical operating ranges**:
  At **idle RPM**, a typical throttle position value is around **10-20%**, depending on engine type and propeller configuration.
  At **Wide Open Throttle (WOT)**, the typical value ranges between **85-95%**, also depending on engine type and propeller configuration.

★ ***Attention*:** At wide open throttle, there is no power increase between 85 and 95% throttle position. Do not adjust your throttle position sensor/level in an attempt to reach a higher percentage.

+Oil pressure

Condition	Pressure
Engine cold start	Max. 8 bar (115 PSI)
Above 2000 RPM	2 – 5 bar (27 – 75 PSI)
Below 900 RPM (**hot oil**)	Min 0.7 bar (10 PSI)

***Note**: Oil pressure is dependent on the oil temperature , engine speed and oil cooler installation.*

As the oil temperature rises, the oil pressure drops (if the engine speed is constant)
As the engine speed increases, the oil pressure increases (if the oil temperature is constant)
Each engine comes with a test run certificate (test run without oil cooler) showing the oil pressure versus oil temperature versus rpm of that particular engine. These values can be used as a guideline to monitor the oil pressure of the engine.

++EGT

EGT varies upon delivered power.
Most important is that all EGT values are +/- equal. EGT values should normally be within 100°C of each other, depending on installation and operations

+++Cylinder head temperature

CHT values must remain within 20°C of each other.

++++Turbo pressure

Turbo pressure must be in 'green zone' AND stable at min. 2200 RPM and min. 40% throttle position.
At start (idle) turbopressure = ambient pressure.

Operating media

Fuel

The engine has been approved with fuels containing up to 20% ethanol content. However, fuel lines, fuel tanks and other components in your installation may not be suitable for fuels[9] containing ethanol.

★ ***Attention:*** Use of inappropriate fuels can result in engine damage.

UL260i / UL350i / UL390i / UL520i

Note: *Red valve covers (and UL350i/520i with engine SN* ***below 223501****)*

AVGAS UL91 or regular unleaded automotive fuel with a minimum of 95 RON/85 MON = 91 AKI [or (RON+MON)/2 method] (USA/Canada) should be used to operate these engines.

UL350i / UL520i

Note: *Red valve covers and* ***engine serial number equal or higher than 223501***

AVGAS UL91 or regular unleaded automotive fuel with a minimum of 91 RON/83 MON = 87 AKI [or (RON+MON)/2 method] (USA/Canada) should be used to operate these engines.

UL260iS / UL350iS / UL350iHPS / UL390iS / UL520iS / UL520T

Note: *black valve covers (blue for iHPS engines)*

AVGAS UL91 or regular unleaded automotive fuel with a minimum of 97 RON/88 MON = 93 AKI [or (RON+MON)/2 method] (USA/Canada) should be used to operate these engines.

AVGAS 100 LL may be used on the above engines if regular fuel is not available.

Note: Due to higher lead content in AVGAS 100 LL, the wear of the valve and valve seats, the deposits in combustion chamber and lead sentiments in the lubrication system will increase.

★ ***Attention:*** Fuel that has been stored for a long time in the fuel tanks starts to degrade. Avoid running the engine with old fuel and replace the fuel in the tanks if necessary.

ULPower itself has not tested additives (such as Decalin) that help reduce lead deposits. However, customer/field feedback shows that, with correct use of this product, there are no adverse effects on the engine.

[9] Hot AND/OR Ethanol containing fuel is more prone to vapour formation and you must ensure your installation, operation and fuel choice does not result in vapour lock or other issues that may affect your ULPower Aero Engine.

Lubricants

We recommend the use of Motul (Competition) 300V 15W50 oil or Aeroshell SAE15W50 oil for all naturally aspirated engines.

Oil level:

Engine	Type	Max. oil level	Min. oil level
UL260/UL350	i/iF/iS/iHPS	3.5 liters (3.7 quarts)	2.5 litres (2.6 quarts)
	iSA	4.25 liters[10] (4.5 quarts)	3.25 litres (3.4 quarts)
UL390/UL520	i/iS/iSRR/iHPS	4.5 liters (4.7 quarts)	3.5 litres (3.7 quarts)
	iSA	5.5 liters (5.8 quarts)	4.5 liters (4.7 quarts)

★ ***Attention:*** The marks on the dipstick (min-max) are only valid when the engine is horizontal! Always ensure that the plane is level before checking the oil level.

★ ***Attention:*** **Naturally aspirated engines:** If AVGAS 100 LL is used frequently, we recommend to use only the semi synthetic oil "Aeroshell SAE15W50" and change the engine oil more frequently (see maintenance manual)

Turbo engines: Only use semi synthetic oil "Aeroshell SAE15W50" when running on leaded avgas! When running on unleaded fuel, Motul 300V(15W50) can be used.

Do not use special break-in oils.

Note: *For Aerobatic engines: Add a bottle ULP Acro+oil (part no.: L0100120) at each oil change AFTER the first 15 hours of operation (after the first oil change- see maintenance manual). This is an additive that was developed by ULPower and is not available on the general market. This proprietary additive provides added protection during aerobatic manoeuvres.*

[10] Oil level including bottle of ULP Acro + oil additive (ULP Part no. L0100120)

Standard operation

Daily/Pre-flight checks

✖ **WARNING:** Conduct checks on cold engines only to avoid risk of burns and scalds!

Make sure ignition is turned OFF when inspecting the engine. Have the cockpit occupied by a competent person.

Turn the propeller by hand in the direction of engine rotation several times and observe engine for odd noises or excessive resistance and normal compression. If irregular, check troubleshoot manual or seek technical assistance.

Check that all spark plugs, leads and electrical connections are secure.

Verify the free movement of the throttle cable over the complete range. Check from cockpit.

Check for any oil and fuel leaks.

Check integrity and security of oil- and fuel- lines, electrical wiring, cooling hoses, baffles, filters, oil cooler, intercooler, alternator, alternator belt(s) as may apply.

Note: *Fuel pump must be switched on to ensure the fuel lines are under pressure.*

Check oil level and replenish if necessary.

Note: *Make sure the oil level is between the min. and max. marks. Before starting a long flight replenish up to max. level. Difference in oil quantity between min. and max. level is 1 liter. (1 quarts)*

Note: *Make sure the (oil and inter-) cooler fins are free from flow-restricting objects, such as leaves, small rocks, sticks and others.*

Inspect exhaust system for damage, leakage and general condition.

✖ **WARNING:** Do not fly your aircraft or operate your engine unless you are satisfied it is airworthy.

Engine start

✖ **WARNING:** Do not start the engine if a person is close to the aircraft.

1. Fuel tap ..... OPEN
2. Master switch ..... ON
3. ECU ..... ON
3. Ignition Coils ..... ON
4. Fuel pump ..... ON

★ ***Attention:*** Run the fuel pumps for a few seconds before starting the engine to avoid vapor lock and ensure fresh fuel from the tank is available. Fuel pressure must be stable and must be minimal 3 bar (43.5psi).

5. Throttle lever ..... set to idle + approximately 25% of throttle movement
6. Starter ..... ENGAGE

★ ***Attention:*** Activate starter for max. 5 seconds only (without interruption), followed by a cooling period of 15 seconds if restart is necessary. Do not engage starter whilst the engine is running. Wait until complete stop of engine.

As soon as engine is running adjust throttle to achieve smooth running at approximately 1200 rpm.

Check if oil pressure has risen within 5 seconds (if not: shut down the engine). Verify if oil pressure remains within the limits.

★ ***Attention***: Increase of engine speed is only permitted when oil pressure reading remains below maximum.

Prior to take-off

Warming up period:

Start warming up period with engine running between 1200 and 1500 rpm, duration depending on ambient temperature, until:

- oil temperature reaches at least 50°C (122°F) (for dual ECU see note on pg. 12.)
- cylinder head temperatures are at least 50°C (122°F)

★ ***Attention***: Always check that temperatures and pressures are within limits.

★ *Attention*: We recommend preheating your engine in low ambient temperatures(below +10°F (-12°C)). It is important to heat the entire engine and oil system to ensure the oil reaches a viscosity suitable for effective lubrication during start-up. Avoid using heated oil dipsticks or similar single-point heaters, as they can cause uneven heat distribution and potential component damage.

Idle speed:

When warm, engine can be set at idle speed.

Note: *Although engine idle speeds of 700 rpm can be obtained, we recommend the ground idle to be at least 850 rpm for smooth running.*

Throttle response:

When ready for departure, as part of your power checks, do a short full throttle ground test. No irregularities may occur.

★ ***Attention***: Boost pressure must be within range (>2400 RPM)

Fuel pressure must be within range

Note: *Check with aircraft/propeller operating handbook, since engine speed depends on the propeller used.*

Note: *<u>As a guideline (for the turbo engine)</u>: The turbo will start to 'spool up' or create boost from around 1800 RPM and have full boost at 2100 RPM (at sea level conditions). When lowering the throttle/Power, the turbo boost will start to lower from 1900 RPM and there will no (turbo) boost anymore around 1500 RPM.*

Ignition test:

The engine is equipped with double redundant ignition. When at 1500 RPM, switch off one ignition coil at the time and verify that engine still operates normally on either of ignition coils separately.

Note: *Setups with one ECU have 2 ignition switches (one for each coil). In a dual ECU setup, each ECU controls 1 coil: turn off one ECU at a time to test the respective ignition coil*

★ ***Attention***: RPM difference between running with coil 1, with coil 2 or both may not exceed 5% of nominal RPM.

★ ***Attention***: In case of a dual ECU system, keep <u>both ECU's</u> always <u>ON</u> during the entire flight!

Take-off and cruise

Climbing with the engine at maximum take-off power (see 'Table 1: Performance') is permitted during a time period of max. 5 minutes.

In cruise, keep the engine power below the maximum continuous power settings (see 'Table 1: Performance') for continuous operation.

★ ***Attention***: Observe that all temperatures and pressures remain realistic and within limits at all times. If engine limit values are at/or approaching red line, reduce power and land as soon as possible if unable to establish flight within acceptable limits.

Do not fly your aircraft if the oil temperature has not reached normal operating values yet (50°C/ 122°F). Low operating temperatures may not eliminate any accumulated water in the engine. The presence of condensate water in the lubrication system has a bad influence on the oil quality.

★ ***Attention***: If there is a backup fuel pump: Operate both pumps (primary fuel pump and backup fuel pump) simultaneously for a maximum of 15-20 minutes (e.g. during take-off/landing or during fuel tank selection).

Engine shut-down

★ ***Attention***: For turbocharged engines, after coming to a complete stand-still on the apron, ensure an adequate idle running cool-down period (5 min) to prevent carbon/glazing deposits from overheated oil. Hard oil residues can obstruct parts of the oil system and lead to damage.

Shut down the engine by switching off power to ECU before cutting off fuel/ignition.

Under normal circumstances, the descent and taxiing may have cooled the engine down, however, the two minutes idle time should still be respected.

Note: *If temperatures are still at the high end of the limits, allow longer engine idling, to cool the engine down before shut-down.*

Engine storage

For long out-of-service periods we recommend the following to protect the engine against corrosion.

- Let engine run until warm, then change oil
- Remove the air inlet filter and insert approx. 30 cm3 (1 Fl oz) of corrosion inhibiting oil into the inlet with the engine running at increased idle speed
- Shut off engine
- Close all openings on the cold engine, like exhaust end pipe, air intake (throttle), venting tube, turbo inlet/outlet, ….
- Spray all steel external engine parts with corrosion inhibiting oil
- Store the engine in a suitable dry and condensation free place, between 5 and 60°C (41 – 140°F).

Abnormal operation

✖ **WARNING:** At unusual engine behaviour, follow the guidelines below and perform the necessary maintenance and/or checks before next flight. **Use the trouble shooting manual as guideline.** All problems and maintenance/repairs/replacements carried out should be noted in the engine logbook.

Abnormal running on ignition check

If you notice a substantial difference between running the engine on 1 ignition coil or on 2 ignition coils, please follow the procedure below.
Find out which ignition coil is causing the difference.

- If one cylinder stops firing: check ignition lead and spark plug of the corresponding cylinder and coil.
- If two cylinders stop firing: check ignition coil, its connection or wiring loom from ECU to the coil.
- If all cylinders stop firing: check ignition coil, its connection or wiring loom from ECU to the coil.

★ ***Attention:*** The engine needs only one ignition system to function properly. The second system is used as an emergency backup. Operating the engine on one ignition system only reduces redundancy/safety, not the power output.

Sudden engine stop

✖ **WARNING:** If prior to sudden engine stop no abnormal noise indicated internal damage to the engine, try to restart the engine, otherwise conduct power-off emergency landing.

Before restarting the engine, check the following:
- sufficient fuel level?
- open fuel tap?
- master and ignition switch on?
- fuel pump switched on?
- fuel pressure within limits?
- electrical system working?
- sufficient battery voltage (if necessary switch off all non-essential electrical consumers)

If you had to do an emergency landing because the engine did not restart, or abnormal noise indicated possible internal damage to the engine, perform the daily/pre-flight checks (as stated before) carefully to pinpoint the problem. Check fuel for possible contamination. Rectify the problem if possible or send the engine for inspection/overhaul to a ULPower authorised service-centre.

Any sudden engine stop should be entered into the logbook, stating the possible reason and relevant circumstances.

Reaching maximum engine speed

The engine is equipped with an electronic rpm limiter. When reaching maximum engine rpm, the engine will seem to hold back and slightly sputter. Throttle back to reduce engine speed.

Exceeding the max. admissible cylinder head temperature

Reduce engine power to the required minimum and verify that the CHT drops. Continue normal flight if the CHT drops back within the temperature limits.

✖ **WARNING**: If the temperature does not drop, carry out emergency/precautionary landing.

Any exceedance of the max. admissible CHT has to be entered into the logbook, stating duration and extent of over-temperature condition.

On the ground, verify that cooling ducts are still in place and air is free to flow over and through cylinder head cooling fins. If problem remains, the engine should be sent for inspection/overhaul to a ULPower authorised service-centre.

Exceeding the max. admissible oil temperature

Reduce the engine power to the required minimum and verify that oil temperature drops. Continue normal flight if the oil temperature drops back within temperature limits.

✖ **WARNING**: If temperature does not drop, carry out emergency/precautionary landing.

Any exceedance of the max. admissible oil temperature has to be entered into the logbook, stating duration and extent of over-temperature condition.

On the ground, verify that oil level is sufficient and air is free to flow through oil cooler. If problem remains, the engine should be sent for inspection/overhaul to a ULPower authorised service-centre.

Oil pressure below minimum

✖ **WARNING**: Oil pressure should be above minimum at all times. If not, shut down the engine immediately or as soon as possible.

In flight, reduce engine power and speed to the required minimum and carry out emergency/precautionary landing.

Any loss of pressure below the minimum required oil pressure has to be entered into the logbook, stating duration and extent of under-pressure condition.

On the ground, verify that oil level is sufficient and that no oil leaks are present. Check that oil lines to and from the oil cooler are not twisted/blocked or leaking. If oil cooler and oil lines are not blocked, oil filter should be inspected and changed. If problem remains, the engine should be sent for inspection/overhaul to a ULPower authorised service-centre.

Exceeding the max. admissible oil pressure

✖ **WARNING**: Oil pressure should be below the maximum at all times. If not, shut down the engine immediately or as soon as possible.

Note: *At cold start, the oil pressure could be higher for several minutes as the oil is still cold and not as fluid, resulting in a higher pressure. Nevertheless, the maximum pressures of both warm and cold engines should not be exceeded as it indicates a problem with the pressure relief valve or oil lines/galleries and thus no/improper lubrication.*

Any exceedance of the max. admissible oil pressure has to be entered into the logbook, stating duration and extent of over-pressure condition.

On the ground, verify the oil level. Check pressure relief valve. If problem remains, the engine should be sent to a ULPower authorised service-centre for inspection/overhaul.

Relative fuel pressure deviates from normal

✖ **WARNING**: Verify that fuel level and battery voltage are sufficient (min 12.7 VDC), and that the electrical system is working properly. If the battery voltage is running low, switch off unnecessary electrical consumers. Carry out an emergency/precautionary landing.

Note: *A change in relative fuel pressure influences the air-fuel mixture. If the fuel pressure drops, the mixture becomes too lean; if the fuel pressure rises, the mixture becomes too rich. Any deviation from the correct air-fuel ratio can influence the power output of the engine.*

★ ***Attention***: A too lean fuel mixture can cause knocking, and severe damage to the engine.

While the engine is not running (ignition off, but master switch and fuel pump on) the same problems should occur.

On the ground, check the fuel or electrical system for the possible cause. Replace filter(s), pump(s), lines, pressure regulator or sensor as necessary.

Test the fuel system with ignition off and the master switch and fuel pump on.

Deviation of turbo pressure (if applicable)

Once the turbo has spooled up, the turbo pressure will remain constant between 2200-2700 RPM and with a throttle position >40% and until the specified height (15.000 ft).

If the turbo pressure is too low, verify that the RPM is above 2000 RPM. Increase RPM (turbo will spool up) to see if turbo pressure increases to a normal value.

If the turbo pressure is too high, the over-boost protection will set in at 1,4 bar/20.3 PSI. Because of the over-boost protection, the engine will lose power. Lower the throttle/RPM immediately.

Any deviation of turbo pressure will influence the power output of the engine.

✖ **WARNING**: If the turbo pressure deviates (from normal conditions), carry out emergency/ precautionary landing.

Any deviation of the turbo pressure has to be entered into the logbook, stating duration and extent of deviation.

Single CHT and/or EGT drop

Verify that both CHT and EGT of the same cylinder have dropped. If not, the CHT or EGT probe or signal input has a malfunction. Correct before next flight.

✖ **WARNING**: A large deviation of both CHT and EGT temperatures in one cylinder, when compared to the others, indicates that the particular cylinder is not firing properly or is not firing at all. The engine will deliver reduced power. Carry out an emergency/ precautionary landing.

If it is not a sensor malfunction, send the engine to a ULPower authorised service-centre for inspection/overhaul.

Knocking

Reduce engine power to the minimum needed and keep engine temperatures well below maximum limits.

✖ **WARNING**: Carry out emergency/precautionary landing.

Be sure that the right fuel type and octane rating have been used.

Low battery voltage

Switch off all unnecessary electrical consumers, as the engine/ecu needs electrical power to operate.

✖ **WARNING**: Carry out emergency/precautionary landing.

To reduce electrical power consumption in flight even more, one ignition system can be turned off. Keep in mind that the ignition backup system is not operating at that time, but in the event of an emergency, can be manually selected by switching the second ignition system back on and switching first off.

On the ground, have the generator, battery and electrical systems checked for any malfunction. Verify that no more than 15 Amps are being used by electrical devices other than the engine and fuel pump.

Prop strike

A propeller strike or sudden stop is an accident/incident in which an aircraft's propeller contacts any object and is forcibly slowed, stopped or damaged. Examples where this may occur include, but are not limited to, landing gear collapse, failure to extend the landing gear, nose-over, contact with parts of the aircraft (such as cowlings or tow bars), impact with a hangar door/building, impact with trees/fences/hedges, hitting water, running in long grass, collision with birds and other animals, etc. It should be noted that not all prop strikes result in visible damage.

After a prop strike or sudden stoppage, the incident must be entered in the engine logbook. The only known safe procedure is to remove and disassemble the engine and completely inspect the reciprocating and rotating parts. Experience has shown that there may be hidden internal engine damage which may result in an in-flight engine failure including broken crankshaft or loss of propeller.

Therefore, ULPower have opted for a mandatory crankshaft replacement, along with any other parts that are found to be damaged, after a propeller strike or sudden stoppage. We have found that this results in a more reliable, quicker and cost-effective solution than NDT or other inspection procedures.
In the event of a propeller strike/sudden stoppage, please contact your local ULPower dealer who will guide you through the required formalities before shipping the engine back to factory or to an officially approved ULPower Service Center.

Any decision to operate an engine which was involved in sudden stoppage, propeller strike or prop damage without disassembly and inspection will violate the warranty conditions. Any decision to fly an engine without complying with the ULPower prop strike directives is at the owner’s responsibility and will immediately void all warranty conditions. As mentioned in the ULPower warranty conditions (available upon request) ULPower Aero Engines will under no circumstances be held responsible for any damage to and/or liability of customer/third party.

Throttle position sensor failure

In the very unlikely event of a throttle position sensor failure, one (1) of two (2) things might happen:

1) The throttle position is read as somewhere within range, but is invariable despite changes in throttle setting (ECU does not read throttle movement).

   The engine shall keep running reliably at the throttle position where the sensor thinks the throttle is, but with higher throttle positions (e.g. faulty read 60%, throttle at 80%) the engine will run lean. With lower throttle positions, the engine will run rich.

2) The throttle position is unreadable by the ECU (disconnected/ shorted signal wire).

   The ECU will immediately go to a 'Wide Open Throttle' condition, causing the engine to run rich as long as the throttle handle is not at full throttle. This gives the pilot the best chance to focus on finding an airfield and landing safely.

Note: The engine will likely run rough at any throttle position different from where the ECU thinks/ determines the throttle position should be. Find the throttle position at which your engine seems to run best and land as quickly and as safely as possible.

Note: In double ECU setups, at least one (1) sensor will very likely remain functional. The engine can be operated on that ECU for the remainder of the flight.

✖ **WARNING:** Carry out emergency/precautionary landing.

General sensor failure

In case a general monitoring sensor (not used by the ECU to control the engine) fails, the ECU will indicate through EFIS (via CANBUS or RS232 protocol) that a sensor failure is present. The flight can be continued, as long as the engine does not behave erratically or unpredictably.

Note: Certified engines and experimental engines using dual ECU setups will both keep the engine running. In the case of a general sensor failure, the flight can continue without issue and the values no longer provided by the failed sensor can be monitored through the other ECU and EFIS. The ECU which is connected to the failed sensor may be shut down.

✖ **WARNING:** The ECU(s) use(s) multiple sensors to control fuel and ignition aspects of the engine. If one of these sensors fail, a check light will illuminate!
Refer to chapter "Check light".

Fire conditions

The following advice is non-authoritative and is only meant as a safety suggestion.

The aircraft flight/ operation manual should state what should be done in case of a fire condition.

Fire while on ground

If a fire develops in the FWF-zone during ground running, ULPower advises to throttle down to idle and shut down the engine electrical power and fuel provisions (including closing the fuel shutoff valve if operable).

If an engine fire handle is installed, it should be pulled as soon as possible, after the engine has been shut down. Evacuate from FWF-zone proximity and extinguish the fire.

Fire while in flight

- Maintain aircraft control, establish safe airspeed
- Shut off engine electrical power and fuel pumps
- Shut off cabin heating (if installed)
- Declare emergency
- Land as safely and quickly as possible
- DO NOT ATTEMPT TO RESTART ENGINE UNTIL FIRE IS COMPLETELY EXTINGUISHED!

Time between overhaul

TBO is 1500 hours or 12 years for i and iS(a) engines – 1200 hours or 12 years for the UL520T. (whichever comes first)

For engines with a serial number higher than 250000: TBO is 2000 hours or 12 years for i and iS engines – 1500 hours or 12 years for aerobatic engines and the UL520T. (whichever comes first)

After reaching this time limit the engine should be shipped to an authorized ULPower overhaul facility.

Revision

Revision 1 (2020- 07 – 01)

Pg 10: To run in a new Engine: …

Pg 12: Deviation from bank Angle: 35°

Pg 16: Engine start => Fuel Pump => if fuel pump relay is not installed

Revision 2 (2020- 11 – 01)

Pg 12: Fuel pressure values

Pg 16: Fuel pressure values

Revision 3 (2021- 06 - 30)

Pg 9: Subdivision naturally aspirated engine and turbo engine

Pg 10: In the case of turbo engines …

Pg 11: Speed and requirements about RPM settings: subdivision naturally aspirated engine and turbo engine

Pg 11: Aerobatic engines for naturally aspirated engines

Pg 12: Add UL520T in performance chart

Pg 13: Add turbo engine specifications at manifold air temperature and relative fuel pressure chart

Pg 15: Add UL520T

Pg 17: Add take-off RPM settings for turbo engine

Pg 18: Engine shut down procedure turbo engine

Pg 22: Derivation of turbo pressure (if applicable)

Revision 4 (2021- 11 - 18)

Pg 1: Update preface according to IM. Add drawing serial nr.

Pg 3: Update safety information according to IM

Pg 6: Delete engine description a view

Pg 7: Delete denominations of cylinders

Pg 9: New chapter warning lights / delete chapter check light

Pg 10: Rephrase running in

Pg 11: Add MAP for VP/CS-prop

Pg 12-13: Operation limits according to IM

Pg 15: Operation media according to IM

Revision 5 (2022- 04 - 01)

Pg 15: Only use semi synthetic oil “Aeroshell SAE15W50” for the turbo engines

Pg 18: 5 min. cool down period

Pg 18: Add engine storage turbo

Revision 6 (22-07-01)

Pg 12: CHT green, yellow, red range adjustment (50-150, 150-170, 170 was 50-160,160-180,180)

Pg 15: Lubric-ant, recommendation use semi-synthetic oil when using leaded avgas

Pg 18: Modification engine storage turbo

Revision 7 (23-01-02)

Pg 9: Checklight warning turbocharged engines

Pg 14: Clarification oil pressure versus temperature versus engine speed

Pg 15: UL350i/UL520i with SN equal or higher than 223501 need min. RON91/MON83

Pg 17: Ignition test in a dual ECU setup

Pg 18: Attention: Operate both pumps at once for maximum 15-20 minutes

Revision 8 (24-03-22)

Pg 10: Update RPM requirements turbo engine

Pg 11: Oil level 4 cylinder acro : 4.5 max -> 4.25 max , 3.5 max -> 3.25 max

Pg 16: Pre-flight check alternator/alternator belt(s)

Revision 9 (25-03-21)

Pg 14: Operating temperatures (outside air temperature)

Pg 15: Valve cover color (pictures)

Pg 18: Both ECU's ON during entire flight – Prefheating in low temperature

Pg 18: Turbo boost rpm (spool up and down)

Pg 24: Add chapter *Time between overhaul*

Revision 10 (26-01-12)

Pg 9: Oil temp green limit from 100°C to 110°C

Pg 10: Add RPM and altitude in operating limits (removed from IM)

Pg 11: Lowered red limit for CHT from 170°C to 160°C,
Added note on differing oil temperature in dual ECU setups

Pg 13: Add throttle position percentages

Pg 16: Add note concerning flow-blocking debris on coolers

Pg 23: Added chapter *Throttle position sensor failure, General sensor failure* and *Fire Conditions,* chapter *Time between overhaul* shifted to **Pg 25**