Wren 44 Kerostart HELICOPTER ENGINE

Excite your sensors!
Unique, miniature gas turbine two-stage engine, fully automatic starting (no-gas req’d), kerosene fuelled, precision gearbox. Up to 7hp (5.2kw) of output shaft power up to 20k rpm, for superb performance in sport, scale or 3D aerobatics. Gearbox matches OS91H dimensions and accessories. Many airframe conversions available.

Owner’s Manual
Sept 2013
WREN 44 Turbine Helicopter Manual

Congratulations on your purchase of a new miniature Wren44 Helicopter gas turbine engine.

This manual has been prepared to help you set up and safely operate your engine in your airframe. If you encounter any problems then please consult this list first and if you cannot find a solution please get in touch with us. The engine is simple to prepare and use but certain precautions must be observed for your safety and others by you – see safety notes.

Included in the manual is a problem checklist to help solve any problems you may encounter in operation. Please remember, although small and seemingly harmless the engine is definitely not a toy and must be treated with utmost care and consideration to your own safety and others around you. The manual also contains sections on the individual components of the installation and operation, refer to these for more detailed information.

Contents:
3 Introduction
5 Package contents
5 Weights and measures
6 Specifications
7 Fuel consumption
8 General description
13 Ancilliaries
16 Safety notes
19 Installation
21 Autostart system
21 Radio setup
24 Failsafe function
25 Services schematic
26 Starting the engine
27 Setting a throttle curve
29 Problem checklist
31 Maintenance
32 Storage
33 Warranty

Precision CNC machined gearbox- fully 3D modelled for perfect alignment and trouble free operation.

Too good to hide!

I’ve got my engine, which heli should I choose?

A question we are often asked is which is the ideal heli to use with the Wren 44Heli unit? It’s not an easy question to answer as much depends on your skill as a builder and your idea of the perfect machine. One fact is, the Align TReX 700 + 800 is by far the most popular choice of helicopter and is very easy to get spares with endless upgrade opportunities. It is well supported with at least four different conversion kits available to convert to the Wren Heli engine and lots of body options too. Which to choose from, or to do your own is your choice.

See the Wren website for more details on the options and contacts: www.wrenturbines.co.uk
https://www.facebook.com/pages/Wren-Turbines/154656198069224
Wren 44 Helicopter Turbine

This unit is a unique miniature gas turbine engine driving through a small gearbox suitable for driving the rotors on pod and boom sport helicopters 0.90cu in (15cc) size upwards and with suitable additional gearing provides adequate power to fly scale helicopters and camera platforms in excess of 50 lbs (23 kg) AUW.

New for 2013 includes new extra compact kerosene start system as standard, which eliminates all the extra components required for propane start in a neat and tidy package.

The engine is usually supplied as part of a complete airframe package but it is not difficult for the experienced builder to convert most large airframes to turbine power, or scratch-build their own models. There are several interesting models featured on the Wren website at www.wrenturbines.co.uk Whatever you are building, there are technical considerations and aspects of safety specific to turbine models and we would like to offer some advice based on our seven years experience designing two-stage turbine helicopters.

SAFETY
This section is intended to cover aspects of safety specific to turbine helicopters. The manual does not cover the flying of the helicopter as it is assumed that the owner has prior flying experience and that this would not be a first model. Turbines are NOT toys and anyone building or operating a turbine helicopter must have suitable skills and experience.

FIRE
There is a small but real risk of fire when operating turbine powered models. Hot kerosene ignites readily and it is almost impossible to put out the fire without a fire extinguisher. Only carbon dioxide (CO2) extinguishers are suitable as powder types will ruin the engine but in an emergency use what you can. Do not operate your engine unless you have an extinguisher at hand. If there is a fire inside the engine, try to direct the extinguisher into the air inlet, otherwise attack the seat of the fire.

HOT PARTS
Turbines generate large quantities of hot gases and have parts that stay hot for a long time after the engine has stopped. Both the exhaust gases and these parts are sufficiently hot to cause serious burns. Make sure that anyone not familiar with turbine operation is aware of this.

Critical components adjacent to hot parts may need protection or spacing away from heat damage by distance or physical protection. An aluminium foil faced insulation material is suitable for wrapping around hot parts of the engine and is available from Wren Turbines if required.

Even in a small airframe like the Mark Symons Bergen Magnum (left) the engine tucks in neat and tidy and enables all the originally supplied transmission and fan components to be used.

The free flow of cooling air negated the need for any further heat resisting processes and proved a trouble free install.
The Wren 44 Helicopter Turbine

Introduction
This development from the highly popular Wren 44 Gold thrust engine, has been on sale since 2009. It was built on the success of the Wren 44 Turboprop and uses the same engine and 2\(^{nd}\) stage components. The Wren Heli engine was the outcome of a long R&D programme primarily concerned with maximising the performance and minimising the aggravation of installing and operating, allowing the flier to get on with the business of flying.

We have been careful to keep the weight of the unit down but have not compromised stiffness, which has shown itself to be a major concern for turbines. The gas turbine is not modified for use in this application apart from a small lubrication port fitted to the case, enabling the full throughput to be used in driving the helicopter rotors, producing performance usually described as “awesome” by all those witnessing it and meaning it is never needed to use maximum power, thus ensuring long life and ease of operation.

The gearbox assembly is strongly built to withstand many hours of operation and is designed for lubrication with a fuel take-off from the engine. All this is automatic and the user need only put fuel (clean!) into the tank, charge battery and go fly!

We have tried hard to produce a compact high power to weight engine capable of filling the gap currently occupied by the noisy and smoky 90'size heli I/C engines and yet keep the package bulk and weight down to allow simple conversion without throwing all the standard parts away. There are a large number of airframes already available in the 15cc (0.90”) size that are attractive for conversion to turbine for the reasons outlined above and are suited for the average club flier to expert flier alike. The low installed weight around 1.4kg compares well with equivalent 2-cycle engines plus tuned pipe and helps to keep the rotor loading sensible.

A major plus factor for this engine is the mountings and output shaft dimensions are exactly mirroring the standard OS91H helicopter engine, therefore any airframe, clutch and fan, designed for this i/c engine will fit onto the 44 Heli engine.

The main areas for modification will be the fan shroud and main frames.

Remember - fit the black washer supplied onto the shaft before the clutch, to avoid bearing damage
Noise is becoming a major concern and the 44 Heli enjoys a remarkably low noise figure, rivalling electric models in many cases. The noise is predominantly rotor noise and a low background whistle, with the smooth application of torque and total absence of power pulses enables a very low perceived noise level to be achieved and which dissipates very quickly with distance. This has major implications for choice of flying site as those in noise sensitive areas will benefit from the absence of the irritating 2-stroke “buzz” associated with normal i/c engined helis.

The Wren 44 Heli enjoys the same highly responsive engine as the Wren 44 Gold thrust version so the absolute minimum throttle lag can be appreciated by those keen on the usual aerobatics and 3D manoeuvres, though we would not pretend the engine can rival the lightning fast response of a racing 2-stroke heli engine, but users will be pleasantly surprised at the enormously wide power band enabling very simple throttle curve programming and flying.

The small engine size (in turbine terms) enables the fuel consumption to be described as “stingy” so no need for dragging a big fuel tank around like typical turbine heli’s, together with the c-of-g issues this presents.

Importantly, the engine is already well established so you are not buying an unproven design. Parts and service is readily available and the hundreds of Wren 44 Gold customers across the world will testify to the longevity and ease of use of this world-beating engine.

Above all – Be Safe and enjoy!

Special thanks to:
Lucien Gerard, a good friend and colleague of all at Wren Turbines, who was the first customer to build a Wren 54 turboprop back in 2002 that flies a whole range of 44 powered models for us and encouraged this development from the start.

Lucien installed and flight tested all the Wren 44 turbo-prop prototypes and was instrumental in development and prototyping of the heli gearbox unit. He made the conversions for the Align T-Rex700 and the Henseleit ThreeDee MP-XL to enable the heli testing programme to proceed. His generous help and feedback has greatly assisted and encouraged us to take this unique development to successful production and beyond.

Luciens two friends Oli Romanus and Greg Concalves (Wren-Team France) supplied the Henseleit Three-Dee MP-XL and Align T-Rex700 helicopters that formed the basis of the Wren44 heli conversion outlined in this manual. We send our grateful thanks for all their hard work and inspiration.

Above, Lucien with his conversion of the Great Planes P51 Mustang, converted to 44 TurboProp in September 2007. Just one of many switched to Wren 44 power.
The Wren 44 Helicopter package contains the following:

1) Wren 44 Heli engine, complete with spacing washer and clutch nut
2) Fuel pump and harness
3) Autostart ECU (Engine Control Unit)
4) ECU data display terminal
5) ECU Battery (2-cell LiPo)
6) Fuel and kero burner solenoids (identical) + “Y” connector
7) Engine extension cable
8) Gearbox access plug removal tool

Weights
Power unit complete with cables 1320g (2.9 lbs)
Fuel pump 88g (3oz)
Valves 45g (1.6oz)
ECU (Engine Control Unit) 35g (1.25oz)
LiPo battery 7.4v, 1500mAh 80g (2.75oz)

Airborne weight 1570g (3.45Lbs)
Typical total heli weight 5.2-5.3kg (11.5Lbs)

Principle Measures
Output shaft diameter 3/8” + 5/16” UNF threaded portion (as per OS 91Heli)
Mounting dimensions – gearbox – as per OS91 Heli
Gearbox mounting holes 4off dia 4.2mm
Length overall, gearbox output shaft to tip of starter 305mm (12”)
Width – engine – 75mm (3”)
Height – total engine to tip of output shaft – 125mm (5”)
Width across exhausts – 160mm (6.3”)
Exhaust exit diameter – 45mm (1-3/4”)
Shaft nut size 12mm A/F
Kerosene burner voltage – 6.5v / 20w
Nominal fuel tank for most heli’s, 650-1000cc, 22-34oz (6 to 10mins flying)

**Performance specifications**

Practical rpm range – 4,000 to 18,000rpm, 3.24Nm, 7hp (5.3Kw) (engine to max 195k rpm)
Peak torque output – 4.05Nm @ 13300 rpm, 7.53hp (5.62Kw)
Peak rpm output – 18,700rpm, torque 2.15Nm, 5.65hp (4.2Kw)

Gearbox ratio - 2\textsuperscript{nd} stage turbine to output shaft - 4.285:1

Nominal recommended maximum engine rpm for normal flying, 90 size heli – 175,000rpm
Nominal recommended maximum engine rpm for aerobatic/3D flying, - 185,000rpm
Maximum engine rpm for extreme 3D (strengthened main and tail rotors) - 195,000rpm

![Chart showing shaft power output at full engine rpm](image)

![Chart showing percentage power output for scaling against engine rpm's.](image)
Fuel Consumption

Charts showing the fuel consumption used for the unit in fl.oz/min

New heli for the Wren 44 unit by Chris Bergen of Bergen Helicopters – the Bergen “Magnum 44” hmmmmm!
General description of the Wren 44 two-shaft drive system

The following notes introduce the main parts of the assembly and offer an insight to the use and operation of the unit as a whole;

The Wren 44 Helicopter Unit is the world’s smallest commercial 2-shaft helicopter engine. It is designed for use in miniature helicopter applications in place of an I/C engine. It is generally suited to helicopters up to 25kg (55lb) in all up weight and will replace I/C engines of around 15-30cc (0.9 to 1.8cu inch).

What is a two-shaft system?
The two shaft drive system means there are two independent shafts running within the unit. The first shaft is contained within the engine end of the unit and rotates at very high speed (up to 195,000rpm) with just a small compressor wheel at one end and axial flow turbine at other end. This forms the gas generator. The engine end of the unit generates a flow of gas at high pressure and volume, and its operation is exactly as a small gas turbine engine. If a nozzle was attached to the outlet of the engine it would imparts a slight squeezing of the gas into a high velocity jet for producing jet thrust as would be the configuration for a thrust engine. For a gas generator version of the engine, instead of squeezing the gas through a nozzle it is redirected by another vane assembly to turn a 2nd turbine wheel mounted on the 2nd stage shaft. This is driven round in the gas stream and this rotation drives the input shaft to the gearbox and onwards to the helicopter drive.

The 2nd turbine is larger in diameter (66mm) than the 1st stage and runs much slower - up to only around 80,000rpm - still far higher than any 2-stroke or electric motor could achieve, but at a higher torque level. The energy given up by the gas driving the 2nd stage turbine drastically reduces the velocity of the exhaust gas with the result than only a small residual thrust remains from the exhaust outlets.

What happens if I stall the output shaft in a bad landing?
In a situation that causes the output shaft to stall, the gas generator will continue to function normally with little ill-effects. On releasing the shaft from its stalled form it will spin back up to it’s normal running speed. This should be born in mind when retrieving the model from long grass or crash situation – never try to pick up the model whilst the engine is running.

What sort of gearbox is required to convert the 2nd turbine speed to something I need?
The rpm generated by the large diameter 2nd stage turbine is from zero to around 75,000rpm depending on loading and gas generator flow. This enables a suitable reduction to be contained in a simple single stage gearbox, the ratio of which is chosen to suit the operational needs of the load driven. The 44Heli reduction is 4.285:1 and this gives an output shaft speed range of zero-20,000rpm. The 2nd turbine has a wide operating rpm range and may be slowed with high load or allowed to speed up with low load without upsetting the 1st stage, therefore the choice of rotor blade or subsequent reduction beyond the engine is not at all critical, providing it presents enough load for the system. The main criteria for reduction ratio choice being the type of heli the unit is fitted to (scale, aerobatic, sports etc) and the length of rotor blade required to be driven.

WARNING - it is most important that there must always be some load on the output shaft as otherwise the 2nd stage turbine will be running unrestrained and may easily speed up beyond it’s safe running speed, even when the gas generator is running at only a modest rpm.
The unit must NEVER be revved up without a suitable load attached.
What is the gearbox arrangement?

The gearbox housing is made up of three pieces, the main gearbox body (green), output housing and blanking cap (both gold) in the base. The output housing is not intended to be undone by customers as it is preset with shims for correct gear backlash and loctited, so please do not undo it. Any evidence of removal will void the warranty. The blanking cap in the base of the gearbox can be removed and refitted and a shaped plastic tool to do this is provided. No further dismantling of the engine or gearbox is permitted.

The front of the 2nd stage turbine shaft carries a specially contoured spiral bevel gear which meshes to a sintered high strength spiral bevel crown wheel. The input shaft is carried on two high precision ceramic high speed bearings with a light preload. The bearings are lubricated with fuel exiting from the gearbox area. The reduction ratio is 4.285:1 and the gear assembly is safe to run to 20,000rpm output speed and 85,700rpm input. Normal maximum speed of this shaft plus clutch and fan would be around 15 to 18,000rpm and remember most tail rotor assemblies are speed rated for these rpm's so take extra care here.

The output gearshaft is supported by a pair of substantial bearings and a wiper type oil seal to retain lubricant in the housing. It is intended that the supplied black washer is slipped on first followed by clutch components which are tightened onto the inner ring of the output bearing. This pulls the crown gear into the precise mesh preset at the factory. A securing nut of the standard pattern is provided for securing the shaft accessories, clutch etc.

The gearbox housings are anodized to resist corrosion and maintain their lustre. The gears are fully hardened and are able to run with long life using just a small amount of engine fuel bled off the gas generator fuel system. The oil percentage in the fuel should be 5% to ensure satisfactory lubrication.

A hole up the middle of the tool enables the pipe to be fed up the middle while removing and refitting the cap – keep a clean cloth handy to catch any remaining lube. The cap is fitted with a sealing O-ring so there is no need for excessive torque to be used in refitting it.

Lubricant is tapped off the main engine pressurized fuel supply and fed with a small amount of air pressure via a mixing nozzle to the bottom of the gearbox.

As the gearbox can get hot in operation the feed pipe is a clear 4mm PTFE heat resistant tube retained to the blanking cap on the gearbox by a knurled screw fitting. Be careful when routing in and around this tube, to avoid kinks that might close off the lubrication supply. If you do get a bad kink, ask for a new pipe, don’t risk ruining your unit by running it dry.

Do not disconnect the PTFE pipe at blanking cap end as it is extremely difficult to do so without damaging it and it may leak if disturbed. Disconnect only on the Festo fitting on the engine and leave the PTFE tube attached to the cap. If the tube end starts getting chewed then slice the last few mm off with a sharp knife (not side cutters).

When you receive your unit you might try to rotate the output shaft and find it tight. This is because the output shaft bearings are spring loaded and without the clutch fitted in position the spring can push the gear into tight mesh. When the clutch is fitted it should then mesh correctly and rotate smooth and sweetly.
How do I lock the output shaft to fit my clutch and fan components?

To enable the output shaft to be locked for attaching output components, clutch etc, unscrew the lower part of the gearbox using the simple plastic tool supplied. **DO NOT** attempt to jam the gearbox shaft by sticking a screwdriver or metal rod in between the 2nd stage turbine blades – you may cause severe damage to the blades and this will not be covered under the warranty.

After removal of the access cap use a clean 12mm A/F socket or ring spanner to the large nut at the inner end of the shaft (which is high-strength loctited to the shaft) to lock the shaft and enable the supplied washer to be fitted to output shaft first, followed by clutch, fans etc, followed by securing nut.

Be extra careful to keep everything clean here and do not leave the gearbox interior exposed as dirt particles getting in will eventually be washed into the turbine bearings as soon as the engine is started up and this may cause permanent damage to the bearings. As we cannot control access to the gearbox interior we cannot warranty 2nd stage turbine bearings, however such access has not proved to be a concern in the development testing.

**It is most important the black washer supplied is fitted before the clutch unit so the clutch cannot foul the top bearing on the gearbox.**

What is the effect of forward airspeed on the engine?

Once the helicopter is in the air and traveling forwards the rotor rpm will increase as its load reduces with forward speed. An rpm increase of 10-15% can be expected in the air so choose a pitch setting that keeps the output speed below the rotor safe maximum.

It is this increase in rotor rpm in the air which gives the turbo-shaft powered aircraft a high airspeed capability and shows a definite edge over it's I/C engine counterpart. I/C engines have a more limited unloaded speed capability, as it can result in the engine mixture strength "leaning out" which can cause engine damage. By contrast the turbo-shaft engine will enjoy running cooler as the rotor speed unloads leading to longer life and reduced loading on critical components.

How is the unit mounted in the airframe?

The unit is housed on the standard i/c engine bearers provided in the heli airframe, by the four M4 mounting holes provided on the gearbox.

The output shaft will then be presented in the correct position for the clutch and fan components as per the normal i/c engine install.

Support is required for the main body of the engine forward of the gearbox and simple aluminium or stainless steel strap around the engine will suffice.
There are several kits for conversions to the popular helicopter airframes. Each has its own method of securing the engine but all are simple and effective. Allowance for heat expansion of the unit should be considered in the mounting.

The aim is to eliminate engine movement while attached firmly via the gearbox as this places very high point loads on the hot section coupling point in the centre of the unit and at the gearbox fixings. Note that 3D flying imposes extremely high forces onto the unit and these must be controlled by a suitably rigid mount.

**Heat issues?**

The exposed metal components between the engine and exhaust are called the *interstage* and will get very hot in normal use. The standard fan and shroud supplied for i/c engine use is ideal to help control this and will help to prevent damaging buildup of heat in the immediate vicinity of the helicopter airframe.

There is no possibility of keeping the unit cool to touch – the gas flow internally will be at 400-500°C and releases over 100kw energy per second but these components are designed to withstand this heat without problems. Aim just to stop other parts being affected by the heat. Bear in mind too, these parts will retain heat for a considerable time after shutdown so please be extremely careful with fingers in this area.

In normal running the gold part of the engine casing will only reach about 100-130°C minimizing the chances of heat damage to the aircraft fuselage and as long as some airflow can get in and around. No further stiffening is required or advised for the unit, this approach enabling the conversion from I/C engine to turbo-shaft power to be accomplished with ease. The mounting should support the engine at the approximate centre of gravity to withstand all normal loads such as might be subjected to during flying maneuvers.

**Aren't gas turbines more dangerous than I/C engines?**

No. Turbine fuel has a high flashpoint which means at normal ambient temperatures it is extremely difficult to ignite, unlike gasoline or glow fuel which is a low vapour temperature and ignites easily. The 2nd stage fully encloses the outlet of the gas turbine section affording a high degree of protection against any component failure due to accidental damage or persistent operation beyond the normal operational duty cycle. The main issues of concern are the requirement for a high degree of structural integrity with the helicopter framework and mechanics, and need to operate the power unit within the capabilities of the helicopter main components like main and tail rotors. As there is little control possible over the choice of airframe the engine is fitted to it is important the user considers carefully the power settings and choice of components used before running the unit.

**What's it like to operate?**

“Magic” – customer quote! The power unit itself is operated as a normal miniature gas turbine and possesses all the standard qualities such as automatic push-button starting and cooling, totally vibration free operation, very quiet running and exceptional power and of course has the “right” noise and smell. The throttle response is of the best in its class - the small gas generator rotor is small and light allowing very quick spooling to be achieved safely. Being a very small gas turbine its fuel consumption has been described as "stingy" - a typical 10minute flight being easily achieved with a single 1ltr fuel tank, depending on the flying style.

**How does it compare to I/C power?**

The exceptional power to weight ratio which is close in performance levels to an 80cc
gasoline engine but with very low weight levels allows the operator a level of dial-in performance previously enjoyed by only those operating high performance specialist engines with tuned pipes etc, with all the attendant noise, extreme vibration and operational issues associated with such equipment. Scale fliers will really enjoy the smooth and quiet response and operation coupled with high power reserve to get out of those difficult situations that scale helicopters with multiple long rotors and lots of fine surface detail, can find themselves in. The high torque ability of the engine allows it to cope well with a wide range of helicopter reduction ratios, so there is no need to swap away from the standard ratios supplied for the airframe. The emphasis on small and compact lends itself more clearly to sport than scale but users will find the engine at home in either role.

**What about smoke?**
The engine itself is a clean burning gas turbine that makes very little smoke in normal operation. However the gearbox bearings are lubricated with a very small amount of fuel, which at low rpms or throttling down can sometimes be seen as a small puff of smoke, but this is normal, there is none of the typical smoke trail of the I/C engine. The oil percentage used in the fuel helps to minimize pollution from unburnt fuel, although the gas turbine does produce a very distinguishable smell which for many is the "raison d'être" for this type of model flying. On shutdown, excess remaining fuel in the gearbox will be blown into the exhaust area and can make quite a lot of smoke but treat this as a confirmation of lube present.

**Can I use the transmission supplied with my heli kit?**
Yes. In all cases we have looked at so far the transmission components are modelled around the standard 0.90cu in (15cc) heli engine and there is a high degree of standardisation in the shaft size and arrangements of such i/c engines. We have continued this standard to our gearbox and output shaft enabling the fitting of standard collet and clutch/fan arrangements supplied with most airframes. Don't forget to fit the black washer first.

Some cutting around of the fan shroud may be needed to clear exhausts etc but modellers with normal hand skills should encounter no difficulties in making these modifications using standard hand tools.

**Do I need to change the standard ratio?**
No. In the cases we have looked and compared the torque curve to, we see very little gain but users will no doubt experiment and may find optimum selections than best suit their particular airframe and flying style. But we would emphasize that for initial flying and testing the standard ratios supplied for use with 2-cycle glow engines will be perfectly adequate.

**How do I go about my installation?**
There are literally dozens of different helicopter kits currently available for the 90’ size i/c engine and all would need some degree of modification to enable the install of the Wren Heli Unit. For this reason it is difficult to give specifics but to show what we have done in the installing on the two prototypes done so far.
The Align T-Rex 700 is shown overleaf offered up into the airframe to see how and what modifications are needed. As it turned out, the standard fuel tank with the kit and of good size so was retained.

The obvious difference is that though the gearbox is largely modelled on the comparable i/c engine outline the turbine and 2\textsuperscript{nd} turbine section is clearly something which has to be accommodated within the fuselage structure itself. The implications for this are some degree of cutting around the existing mainframes and some additional structure and in other cases simply replacing the mainframes in their entirety.

Canopies are generally quite narrow and so we have made the exhaust width small with short outlets to enable most to be eased into position after cutting suitable apertures to clear. It is important to have some clearance around the outlets to prevent the canopy from suffering heat related damage – at least 5mm all round.

Fuel tanks are often increased in size from the standard supplied and these larger tanks need careful positioning and secure mounting, safely clear of the engine exhaust heat. This Align T-Rex 700 tank was ok at the standard 630ml and was retained.

Virtually standard practice in heli’ installs is the use of Velcro type fastening to hold critical parts such as battery and receiver in position and turbines are the same.

The turbine installation is virtually completely vibration free so no need to go mad on the soft packing.

Clearly visible here is the good clear space around the hot 2\textsuperscript{nd} stage parts, give them lots of clearance from the airframe and anything else that doesn’t like getting hot. Important not to allow the hot air to collect and stagnate inside the canopy.

The clutch and fan arrangement is nicely shown here on the “Three Dee” plus the replacement home-milled carbon side frames used on this conversion.

The modern day predominance of 2.4GHZ systems make long aerial routing a thing of the past. Aim to keep the receiver well away from the heat though.
A lot of offering up is the order of the day on conversions, getting the canopy mountings in the right place is tricky once the side frame has been cut off.

This T-Rex 700 canopy has a nice cut-out right where the exhausts exit making for a very neat finish.

Between the side frames and under the engine on Oli Romanus’s “ThreeDee” is fixed a carbon plate carrying the fuel pump, kero igniter and fuel valves.

The fuel pump shown is an earlier bulkier version, the supplied pump is now much smaller and neater with a purpose made mounting bracket.

Note the inline fuel filter fitted AFTER the pump. This is to ensure no air bubbles can enter the inlet side of the pump and cause cavitation and possible flameout.

**Ancillaries supplied:**

ECU (Engine Control Unit)
Data display terminal
Fuel pump
Fuel and kero burner valve
ECU battery

**ECU (Engine Control Unit)**

The ECU and ancillaries are identical to the thrust engine variant and use similar programmed settings although a reduced maximum rpm setting is supplied which users may adjust after flight trials.

It is very important however, that users do not change other settings from those set without referring back to Wren Turbines.

The ECU is the new V10 Xicoy type supplied by Gaspar Espiell and which the engine, fuel pump and ECU battery plugs into. It controls the engine through its starting, running and cooling down phases. A signal lead from your receiver connects to the ECU and provides the throttle commands to the engine from the receiver throttle channel and next to it is the larger socket for plugging in the regular Data Terminal which displays settings and is used to input changes (see below).

The ECU unit has a printed label which shows where all the engine accessories are plugged in; “RPM” - rpm pickup (the servo-type lead coming out of the cowl of the engine), “EGT” - temp’ probe, “Fuel” - fuel valve, “Prop” - propane valve – used for the burner valve.
To orientate these servo-type leads, the “-” refers to the brown wire. There are various timers that are used to keep track of running hours – see the detail section on setting the ECU.

**Data Terminal**
The ECU is accessed from the outside world by a port with a three pin servo connector and a hand-held unit called the Data Terminal. This terminal is primarily a display for the engine but is also used to input settings from buttons on its front panel. The terminal’s functions are described in more detail later. The engine may be started and run without the data terminal but first starts should be monitored using it connected.

A miniature version is available which can be mounted in the airframe and is ideal when you progress to the flying stage.

**RPM Pickup**
Mounted on the front of the engine, under the green meshed FOD screen is a hall-type magnetic rpm sensor. It picks up a signal from a small magnet fitted into the compressor nut one the end of the shaft of the engine. The signal terminates in a servo-type plug which plugs into the rpm input on the ECU. It can be affected by stray electrical interference so keep servos or other high current devices clear and be careful about routing cables close to it. The starter cable is tightly twisted to reduce their stray signal for this reason – do not untwist it.

**Temperature probe.** The temperature probe is a standard miniature industrial “K” type thermocouple which is positioned in the interstage casting and attached to the engine. It senses the exhaust temperature of the engine and feeds this information back to the ECU.

Temperature information is used to detect sufficient pre-heating at the engine start phase and correct operation during normal running. On shutdown, the temp’ probe indicates to the ECU when the engine has cooled sufficiently during the cool-down phase. It is attached to the engine and should not be moved from this position.

**Fuel Pump.**
The fuel pump is a special magnetically coupled gear type pump made for the Wren 44 Gold engine. It contain very small gears to allow a wide range of control for the engine and must never be substituted for anything else. Almost all other turbine fuel pumps are much too large and are therefore not suitable for this application and result in loss of control on this engine.

Be very careful whenever disconnecting or connecting it to ensure there are no small slices of pipe left at the inlet or outlet. The pump may not be dismantled without voiding the warranty.

When people say that “cleanliness is next to godliness” they are referring to small turbine fuel pumps. Treat this component with total reverence and keep it spotless. Always carefully blank off the pipes with clean blanks, when moving it about. The smallest particle can ruin the operation of this pump so only allow clean fully filtered fuel into it. Connect to a fuel tank by a single largish diameter direct pipe pushed over the 4mm clear pipe supplied on the pump, with no connectors, fuelling valves, stoppers etc between it and the fuel pickup. The fuel tank pickup should be a quality felt type clunk or proprietary pickup with fine filtering qualities.
**ALWAYS** carefully filter the fuel going into the tank, don’t rely on the pickup to stop particles getting in. If a tank gets badly contaminated then discard it – this engine is far too costly to risk a dirty tank. Be careful also to ensure any tank vents cannot suck grit into the tank. A filter on the air vent is not going too far to keep the fuel pump in tip-top condition.

**Fuel and kero burner valves**

These are identical and interchangeable. To the side is a flow direction arrow which should be noted and adopted.

Test by simply blowing through while plugging it into a spare servo outlet on your receiver. There should be a click on powering. If it fails there is little to be done but replace it. The quick release connectors can be removed for re-use first though. A test function for each valve can also be accessed on the ECU via the “TEST” menu on the HDT.

**ECU Battery**

The ECU battery supplied is a 2-cell 7.4v Lithium Polymer (LiPo, capacities vary according to supply. The capacity of this should be enough for at least three to five good flights but initially we recommend you charge after each flight to keep tabs on how much is being taken out by the flight.

Many fliers try to use regulators on their helicopter in order to try to use a single battery for ECU and receiver. Experience shows this does not work. The fuel pump needs high current pulses to operate correctly and a regulator cannot handle this. Keep the batteries separate.

Only charge using a charger which includes a balancer to keep all cells equalized. The battery includes a balancing lead, you must charge through this to ensure the balancer can work correctly.

**Warning.** It is very important you disconnect the battery from the ECU before charging, or permanent damage will result (chargers emit high voltage pulses). Such damage is checkable and ECU’s so damaged will not be replaced under warranty. It is strongly recommended to remove the battery from the airframe and charge in a safe area.

The Wren team witnessed a serious battery fire on a heli, caused by charging a LiPo without ever using a balancing lead. The battery had become unbalanced and broke down on charge. In this case the battery was inaccessible and the model went up in flames and the owner could do nothing to stop it and was a very unhappy sight. Always use a balancer.

**Battery care - after flying.** It is most important that the battery is disconnected at the end of your flying session. The ECU uses only a few milliamps when shut off but this can discharge a LiPo down to nothing in a couple of weeks. If this happens the battery will be deep discharged and may be permanently damaged – ie scrap. A LiPo so discharged will not be covered by the warranty.
Hopper Tanks and UAT’s
Hopper tanks and UAT’s (originally the Ultimate Air Trap from BVM Models but others are available now) are a popular choice and can help with continuity of fuel supply – especially on aerobatic or 3D helis. The standard hopper tank is simply a small capacity fuel tank which is fully sealed and has a single fuel-in pipe and a fuel outlet positioned centrally so it can pull fuel from any attitude the heli finds itself in without the possibility of pulling in air.

The UAT is similar to the hopper tank except it has a membrane type pickup on the fuel-outlet which acts as a sponge and allows fuel to pass but without allowing air into the system.

Fit the UAT or hopper tank as close as possible between the fuel tank and fuel pump – take great care to ensure a totally fuel tight pipe run from tank to UAT/hopper and then onto the fuel pump. Purge all air bubbles from the UAT or hopper before use. Monitor the remaining fuel level in the UAT/hopper as this is a good indication of air getting into the system. If this level drops noticeably during a flight and there is still fuel remaining in the tank, then suspect an air leak, find and cure it before it causes a stoppage and enforced autorotation practice.

UAT’s are very helpful, but keep the tank capacity well above the flight time requirement so the system never runs out of fuel and the tank clunk is not chasing the last dregs of fuel around at the bottom of the tank. The UAT will not cover up a poor fuel installation.

The regular fuel tank does just fine for Greg Goncalves Align T-Rex 700 shown here – neat!

All in weight of 5.2kg plus 630ml of fuel – enough for about 6-7 mins flying.
SAFETY NOTES

We make no apologies for positioning these notes early in the manual. Please read the following for your own safety and those around you - thank-you.

This engine is not a toy and can cause bodily harm to you or others if misused.

It is your responsibility as owner, to ensure safe, careful and considerate operation of your engine at all times, and in accordance with these instructions.

If you sell or give away this engine, please pass these instructions to the new owner.

This engine must only be run firmly attached to a secure and sturdy model installation. Twisting and rotation forces can be very considerable for such a small size unit and mountings must be sufficient to withstand such forces. Use appropriate screws and proper fixings. The engine must never be run held in the hand or clamped in a vice.

This engine is an internal combustion gas turbine engine which generates large quantities of heat – ensure the mountings and installation are appropriate for operation at these elevated temperatures.

During operation and for a time afterwards there are parts of the engine which are hot enough to cause serious burns – do not touch any part of the engine until it has cooled to room temperature.

Always operate your engine in open air away from confined spaces as the engine exhaust contains gases which can cause asphyxiation and nuisance from smells.

The exhaust gases are very hot (over 400°C) on leaving the engine and can cause burns to skin or damage to objects close to it – keep exhausts clear of anything which is affected by such heat.

This engine must not be used near flammable gases, liquid or materials.

Always keep a CO₂ or similar fire extinguisher close by when operating this engine.

Turbine fuel is poisonous to living beings. Keep it away from the mouth and eyes and from contact with skin. Always store it in a marked container out of reach to children.

Turbine fuel has a relatively high flash-point but in certain circumstances can be highly flammable. Keep it away from heat and sources of combustion.

Turbine oils can be hazardous to health and must not be allowed to come into contact with skin, mouth, eyes or through ingestion, accidental or otherwise. Take care when decanting and ensure any spillage is wiped away immediately and clean any affected area with warm soapy water. Wash hands and any affected part immediately after any contact.

Turbine oil can discolour or affect certain paint finishes.

Take precautions to prevent spillage. Do not discard or allow any spillage to run into drains.

If removing the kero plug to test it, keep fingers or bare skin away from possible burn from the glowing element, it heats in 1 second to over 1000°C – use a metal tool or appropriate insulation.
As operator, it is your responsibility to ensure any spectators (especially small children) or helpers are kept well away from the helicopter whilst it is operating – at least 20m away. The safest position to operate the engine is from behind, at least 3m (10ft) away. Any sudden movement rearwards will at least be limited by the tail rotor. The area sideways on and to the front of the helicopter is potentially the most dangerous area due to the rotating rotor and you will have little notice if the heli suddenly starts to tilt towards you. In certain light a turning rotor blade can become almost invisible – add some colour to the rotor tips if you notice this with yours.

**Do not** start the engine in a pit area as safety distances are difficult to maintain and passers-by can appear without warning and once the rotors are turning fast you cannot stop them quickly if you needed to. (In a recent incident, a dog ran up to a heli in the pit area almost at take-off rpms – tried to sniff the end of fast spinning tail rotor…)

The helicopter should be placed at the take-off point where the start and take-off may be done safely, away from onlookers where you are between the heli and any onlookers. This way you as the operator have plenty of space to stand well clear and can step in any direction without falling over someone. Never allow someone to hold onto the model while you start the engine, always stand well clear.

Accordingly, NEVER ever attempt to start or run an installed heli engine in an enclosed space such as a garage, workshop or small back yard. Quite apart from the exhaust dangers, it is not possible or safe to attempt to restrain the heli safely and if anything happens you may not be able to get clear quickly enough.

Keep any helper close to you and brief them fully on their duties before starting the engine. One helper should carry out the role of fireman and ideally as caller, to watch for other models or flying activity beyond your vision. Ensure they are aware of what to do in event of emergency and where to position the extinguisher if required. Ensure they are briefed NOT to attempt to approach the heli if the rotors are turning, whatever the incident.

Never attempt to alter the starting characteristics of the engine by spraying ignition agents into the intake, as used for gasoline and diesel engines. A dangerous fire and flashback may result.

Please note, the exhaust of a gas turbine has a pleasing smell to enthusiasts of gas turbines but others may find it offensive. Please have consideration for others when running your engine in their proximity.
Installation

DO’s:

Ensure adequate supply of cold air to the engine intake through access holes in the canopy. This must be an independent supply and isolated from the warm/hot air area inside the canopy. It is good practice but not absolutely required to fit a coarse wire mesh at the entrance of this area to prevent build-up of grass, flies etc from clogging the engine intake. An ideal material for this is the high quality stainless mesh available from Wren Turbines at modest cost.

Ensure adequate ventilation of the stagnant area around the engine and 2nd stage and to prevent build-up of heat around the exhaust sections from distorting the canopy or affecting the paint finish of same.

Ensure the area of the canopy is properly sealed using a sealer approved for use with turbine fuels and oils.

Engine should be mounted using the four bolt gearbox mounts plus a supporting strap around the engine. No other means of mounting the engine is required.

Ensure at least 5-6mm (1/4") of clearance around the exhaust from any part of the canopy. The exhausts get hot in use and may distort or discolour the finish if clearance is too small.

The fuel pump should be mounted at least 100mm away from the intake of the engine. The pump can emit electrical pulses that cause the speed sensor to transmit incorrect rpm information to the ECU.

The fuel pump should ideally be mounted with the spindle in the vertical position with the motor uppermost and the black cap downwards, alternatively mount the pump horizontally. Note the pump is supplied fitted with built in suppression to reduce radio frequency noise.

The centre of the fuel tank should be mounted laterally as near to the centre of gravity (C of G) of the model as possible. This will minimise the C of G shift as the fuel is used during flight.

If breaking a quick release “Festo” connection, always trim the last 6mm (1/4") from the end of the tube to expose a fresh area for the connector to seal onto. To release a “Festo” type connection, push the blue ring inwards with one hand and gently pull the tube out with the other hand, whilst holding the collar in its retracted position.

The air ducting to the inlet of the engine must have a minimum area of 2500sq mm, (4sq") equivalent to at least 50mm (2") square.

If an extension to the exhaust ducting is required, it should be approved by Wren Turbines.

Care should be exercised to ensure that no foreign object, loose parts of model, or debris is allowed to enter the compartment where the engine is installed.

If required, it is approved to extend the rpm and exhaust thermocouple wires using a high quality gold plated “JR” type servo extensions – Futaba are not suitable as the pin sizes are different. Plug/socket extensions should be secured with heatshrink or a cotton tie to ensure they cannot pull apart.
**Fuel**

Only use paraffin / kerosene or Jet-A / A1 or an equivalent fuel. This fuel should be filtered at each stage of mixing and transfer to model fuel tank. The pickup filter (provided) must be fitted to the fuel tank. This should be maintained to ensure correct operation. A UAT is ideal to be fitted between fuel tank and pump, use no other connector in series.

A final fuel filter is already fitted to the engine in the fuel line just before the green cover. To disconnect the fuel line from the engine, disconnect this at the quick release connector on the fuel filter. Do not break the line to the engine AFTER the inline filter.

**Lubrication Oil**

This fuel requires an approved lubrication oil mixed at the rate of 5% oil to 95% fuel by volume or weight. This is recommended for all Wren engines and it also provides lubrication to the gearbox. Don’t use a lower oil percentage than this as it can cause early failure of the gearbox and/or bearings. Most important in the oil choice is that it must stay mixed to the fuel and not settle out. If in doubt, mix up a jar of fuel with 5% of the chosen oil and leave for 7 days. If it separates out, it is not suitable. If there are small patches or bubbles of water in the fuel, reject it.

Suitable standard turbine oils are available from airports and jet suppliers and most work very well. These burn cleanly and leave almost zero deposits, but most are carcinogenic and hazardous to human health when burned so can only be used with care and in wide open spaces.

**Suitable turbine oils are:**

- Aeroshell 500
- Exxon 2380
- Mobil Jet Oil
- Castrol TTS

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- Aeroshell 500
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- Mobil Jet Oil
- Castrol TTS

Certain low ash, mineral based 2-cycle oils are also suitable. Some of these leave a sticky gummy deposit on the bearings and inside the exhaust casing so are not good. Many are synthetic and do not stay mixed to the fuel so are also not good. Some sold for lawn mowers and chainsaws in the supermarkets have been found to work well and leave low deposits and are easy to obtain in a small container. These are often coloured making it easy to see the fuel level and check if the oil has been added, these are obvious advantages.

There is also a hydraulic oil used in industry called “Mobil DTE Light”. This is almost colourless, odourless and leaves no deposit when burned. It is not hazardous to handle or carcinogenic. This has been used very successfully and is highly recommended, but it is only available in large containers. A couple of drops of food dye will help you to be sure you added the oil.

Whichever oil you decide on, mix 50ml of oil for each 1Ltr of fuel (1 oz oil per 20fl oz fuel or 6.5fl oz per US gallon (128fl oz) fuel), seal the container and shake well to mix thoroughly. Handle these fuels and oils with care – avoid all direct contact with skin. In case of contact wash the affected area with soap and warm water immediately.

If you forget whether you have added oil or not, it is safer to add a second lot of oil than to risk ruining your engine by running it without. In all cases, pipe-work used must be of the type supplied by Wren Turbines or an approved turbine supplier. NEVER use silicon (glow type) tube as the fuel and oil will melt it.
Fire Extinguisher
Equip yourself with an appropriate fire fighting extinguisher whenever you are planning to run your engine. The best extinguisher for our purposes is the Carbon Dioxide (CO₂) or any gas extinguisher. Use of dry powder, foam or water based extinguishers will cause serious damage to the engine and should only be used as a last resort when there is nothing else.

DON’Ts.
Never mount the engine using self tapping screws – it is impossible to ensure they cannot loosen or pull through. Use only cap head screws with nyloc type lock nuts

Do not use second hand fuel tube – it can harden with use and not allow a proper seal.

Silicone tube must never be used anywhere in the installation as it is dissolved by the fuel and oil.

Do not install filters in the feed (suction) line from the fuel tank to the fuel pump. This is known to cause aeration of the fuel and flow disturbances resulting in stoppages.

Do not use fuel which has not been properly filtered. Dirty or contaminated fuel can result in blockages of the fine fuel injectors in the engine or blockage of the engine lubrication system and subsequent bearing damage.

Don’t cut the fuel line between the filter and the engine as this can allow debris to enter the engine fuel system which can cause severe damage to bearings and combustion system.

Do not try to run the engine without rotors fitted. The head can easily overspeed in a couple of seconds and the excessive rpm can break the tail rotor.

Do not try to run the engine with just the clutch shoe drum fitted to the output shaft. If the output shaft starts spinning fast it can cause the clutch shoes to snap off the drum and fly outwards at great speed and can cause you or someone nearby, serious injury.

Don’t ever try to run the heli to speed by tying it down to a workbench or hard surface. It will surely wriggle itself into a total wreck in a most dangerous manner. If you are lucky it won’t get you but if you are not, those rotor blades are like a couple of bit swords….

BIG NOTICE
There is NO safe way to run your heli engine to full power on the ground so please don’t try to.

The engine has already been test run to full power at the factory WITHOUT the 2nd stage fitted, during the build process and to set up the ECU.

You do NOT need to repeat this nor should you attempt it.
**Autostart ECU system**

The Autostart ECU (Engine Control Unit) supplied with 44 Helicopter engines is a Full Authority Digital Engine Control (FADEC) from Gaspar Espiell. It handles all aspects of starting, operating and shutting down the engine and maintains temperature and operating rpm within safe levels. It has an integral failsafe which will shut the engine down within one second of loss of datastream from the receiver. This meets the requirements of the AMA in the USA.

The Autostart main unit should be positioned on the helicopter airframe with the socket for the Data Terminal in an accessible position as you may need to plug this in to monitor starts or change settings. If needed, this socket point may be made more accessible by fitting a JR type servo extension and the socket located in a handy position on the airframe.

Alternatively, a handy mini-HDT is available which can be permanently affixed to the airframe and this saves plugging in and out. This has the added benefit of being backlit for easy reading though of course the buttons may be less easy to locate and operate.

The ECU can be mounted in any accessible position – people often use a hook & loop type strip but keep it clear of the exhaust or hot areas. The ECU has an LED (light emitting diode) next to the signal wire from the receiver and the data display terminal socket, that shows its status when the terminal is not plugged in.

The fuel pump, fuel and propane valves need to be connected into the socket positions shown on the ECU label. Note, the fuel valve label is on the side of the ECU – not obvious from the front. The plug polarity for the valves is not important.

The rpm and temperature cables from the engine should also be plugged into the ECU – be careful to locate the plug brown wire to brown end of the socket. Keep a small amount of slack in all these cables to ensure they cannot pull out during manoeuvres. The ECU battery cable should be routed in a way which allows the battery to be easily disconnected whilst charging. Permanent damage will be caused to the ECU if the battery is charged without disconnecting it from the ECU while charging. Once all items are installed and connected the ECU can be aligned (set up) to your radio.

**Setting the ECU to your radio.**

Disconnect the ECU battery if it was plugged in. Plug the display (data terminal) into the ECU. If you have a transmitter with digital trims you can simulate the trim up/down function using the “Throttle Cut” switch, which is usually a function switched through a switch mounted on the transmitter. Consult your radio manual for this function.

Setting the ECU using this, is done in the same way except that when “trim-up” is required you switch the “Throttle Cut” to off, and when “trim-down” is required, you switch to “Throttle Cut” on.

For initial testing the digital trims can be used if you don’t want to have to explore the “Throttle Cut” function just yet. The trim up/down function is used to switch the engine to “ready to start” and “off”, and would not normally be used to vary the idle rpm.
Setting up ECU (Engine Control Unit)

Remove all rates, mixes and throttle travel settings in the transmitter. The setup assumes the use of a transmitter with manual trims. If you have a transmitter with digital trims see note on previous page. As the display does not photograph well we have reproduced the display readings as a green box.

Turn on the transmitter and receiver. On power-up the screen should come on and after a few seconds should stabilise to the opening screen and should show as right: (If the temp’ probe is not connected it will show as 0°C). "T” = ambient temp’. There are four buttons on the display. The buttons are: ▼ ▲ - +. To scroll through the different screens use ▼ ▲. The buttons - + are used to change the values stored.

Press the Up button (▲) and scroll through the menus until you find the one showing:

Press the minus (-) button and the screen will change to:

Press the + button to enter the radio setup screen. You should then see this screen:

On your transmitter, place the throttle stick and trim to maximum and press the + button to set the value into the ECU.

The screen will now change to:

Move the throttle trim (or switch the “engine cut” switch to on) and throttle stick back to zero and again press the + button.

The display will now change to:

Leaving the throttle stick in the minimum position, raise the throttle trim to the max position or switch “Engine Cut” switch to off, and again press the + button.

The display should then show:

Lower trim to zero. Now switch off the receiver.

Turn the receiver on again, if you have done all the steps correctly the opening screen will show “Trim Low” and if you raise your trim to full it should change to “Ready” and a blue led will light on the ECU. Lower the trim and the light should go off – this means the engine would shut down if needed. If it does not, you may need to reverse the throttle channel on...
your transmitter and repeat the radio set-up. **Do not attempt to run the engine without checking the trim-down will shut the engine off.**

This completes your radio set-up. It should only need doing again if the radio settings are changed or installation moved to another radio but it is worth rechecking periodically.

You will note there are many settings, which can be adjusted in the ECU – many are to adjust the kero start system. Please resist the temptation to change things as firstly this is unnecessary as they have been preset and tuned at initial assembly for optimum performance of your engine, and secondly you may change something which will adversely affect the starting and running of the engine.

**Running Time Counter.**

Using the 2nd left hand button (v), scroll through the menu’s to the last menu.

<table>
<thead>
<tr>
<th>Timer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tot:0000m</td>
</tr>
<tr>
<td>Last: 000s</td>
</tr>
<tr>
<td>Cy:000</td>
</tr>
</tbody>
</table>

The screen contains a timer which shows:

- the total running time of the engine in minutes (Tot),
- the time in seconds of the last engine run (Last)
- the total number of starts (cycles - CY).

*Use this screen to keep track of your total running time and starts.*

**Basic ECU Settings**

These are the *initial* settings used in setting up the ‘Fadec AU107’ ECU to the engine.

These are then optimised to suit each engine.

- **Max rpm** – 175,000rpm (user adjustable up to a maximum of 195K).
- **Idle rpm** – 55,000rpm.
- **Stop rpm** – 28,000rpm.
- **Start temp’** – 100°C.
- **Max temp’** – 800°C.
- **Acceleration delay** – 8-12.
- **Deceleration delay** – 10-15.
- **Stability Delay** – 100.
- **Pump start point** – A number between 30 and 40.
- **Pump Start Ramp** – 004.
- **Glow plug power** – 6.5v.
- **PW limit** – 600, with Hausl ZP25M15 magnetic fuel pump.

*The last item – PW limit may need raising if you need to operate your engine above the 175k rpm setting:*

*Raise PW to 650 for up to 185k rpm, 700 for up to 190k rpm, or 750 up to 195k rpm. Do not raise the setting if you are staying with the 175k rpm limit as it can cause throttle instability.*

*Do not change the values present in your ECU without referring back to Wren Turbines.*
ECU FAILSAFE FUNCTION

The ECU contains a failsafe function that will stop the engine in the event of loss of radio link or continued radio interference that masks the normal signal, but will allow the engine to continue to operate in the case of short glitches. The system works with PCM, PPM and IPD systems.

PPM systems

In case of loss of radio link, corrupted or signal pulses outside the programmed window of operation, for the first 0.5 secs the FADEC will do nothing and keep the engine at its last valid setting. If during this time the radio link is recovered or signal pulse-width returns to within the programmed window, control is returned.

If after this 0.5secs the signal still is missing or bad, the FADEC will command the engine to "idle", and keep it at idle for a further 1.5secs. After this 1.5secs (total 0.5+1.5secs=2secs) the FADEC will command the engine to shutdown.

If the signal returns during this 2s, the FADEC will take this signal as good and reset the 2secs timer and engine control will return.

PCM/IPD systems

The user should program the “failsafe” function of the radio to send a signal lower than the normal "stop" signal (ie if normal “stop” is –100%, then program the failsafe to output –125%).

When the receiver enters into "failsafe" mode, it will issue a signal to the FADEC of -125% that is outside the valid command window, (between STOP (-100%) and Full power (+100%) . In this case the FADEC will follow same procedure as described in PPM mode and shutdown the engine after 2s of failsafe. In this event the FADEC will record the cause of shutdown as a “Failsafe” shutdown.

If the failsafe setting is programmed on the TX to the same point as the “STOP” command, the system will act exactly the same, except that the FADEC will record in its memory that the cause of the last shutdown was "User-Off". This could make it more difficult to troubleshoot a in-flight shutdown.

This system allows the engine to fly through minor interruptions of signal or glitches, thus avoiding the engine shutting off unnecessarily, while maintaining the safety of automatic shutdown in cases of loss or corruption of radio link.

IMPORTANT - ALWAYS PROGRAMME THE FAILSAFE TO SHUT OFF THE ENGINE. NEVER FLY A TURBINE HELICOPTER WITH THE FAILSAFE SET TO “HOLD”.

Wren 44 Gold Helicopter Owners Manual   Page  26
How does it work – the kero start system?

You don’t need to know any of this to run the engine and fly your helicopter but for those who are interested the following may help to explain the kerosene starting process:

The kerostart system is basically a form of pre-heating to raise the temperature of the combustion chamber to the point it can vapourise kerosene and make it combust. In earlier times this was done using propane gas but now we can do this directly from the liquid fuel.

Heating is achieved by igniting and burning a small amount of fuel using a small plug called the Burner. This is a small ceramic element enclosed in a stainless steel housing with a very small clearance around its tip. The housing fits in a hole in the engine case with the exit in the combustion chamber. A high temperature PTFE O-ring seals it in the housing. If the burner needs taking out to clean or replace, the O-ring will need replacing too as the heat will deform it so don’t take out the burner unless there is a problem.

The element is heated rapidly by passing electrical current through it and its tip glows bright yellow in a couple of seconds (voltage set in (“Glowplug Power”). Kerosene fuel is then pumped in small pulses through the narrow gap next to the glowing element and it bursts into flame. This flame then provides enough heating in the combustion chamber to allow fuel to vapourize when passed down the vapourizer tubes in the normal way.

The amount of fuel used for the burner is very small and the fuel pump is unable to run this slowly in a reliable way, so the solenoid valve supplying the burner switches on and off rapidly to help regulate the flow. The longer the valve stays open the more fuel passes and this is how the ECU controls the flow.

The setting for this is important as too little flow and there will only be a small flame, but too much and the element may be cooled so much the fuel fails to ignite into flame. Also, if the engine is spinning too fast while the small flame is going it may blow the flame out, so rpm must be carefully controlled (“Starter Power at Ignition” and “RPM Ignition Kero”).

This stage is called Ignition.

In the ECU, the amount of fuel fed to the burner is controlled by the function “Pump Power Ignition Kero” in the START menu and the engine speed after the burner has ignited, is controlled by “RPM Ignition Kero”.

Once the ECU has seen enough temperature rise from the small flame it will begin pulsing the main fuel valve to the combustion chamber in addition to the burner - a very small amount initially so as to establish combustion properly. This stage is called Preheat. Functions used at this stage are “RPM Preheat Kero” (sets the rotor speed at this point) and “Engine Preheat Fuel” (amount of fuel allowed into chamber).

Once the ECU has seen enough temperature rise (set in “EGT End Preheat”) it will gradually increase the starter speed and main fuel valve opening time to increase the fuel flow to the main chamber and conversely reduce fuel flow to the burner until it is shut off completely. This stage is called Switchover.

At switchover the fuel pump is driving at a new rate set by a number - “Pump Start Point” and the rate of increase of the starting is set by “Pump Start Ramp” and the initial %flow through the fuel valve is set by “Engine Min Flow”. This %flow and increasing rpm continues increasing as the engines accelerates up to the point where the fuel valve is 100% open – display then shows “FuelRamp”. The fuel pump power keeps rising until the starter is no
longer needed (“RPM Off Starter”) and continues until the engine reaches idle at 55,000rpm. All this takes about 25 seconds.

Note we have highlighted “Pump Power Ignition Kero” and “Pump Start Point” in red as these are the main adjustments needed to “tune” for a new fuel pump or adjust for a worn one.

Quick start installation, mechanical:

Mount the fuel pump, ECU and valves. Place valves as close to engine as possible.

Push on (yellow) Tygon feed from tank.

Push on Tygon tube from tank to UAT or hopper tank inlet.

Push on Tygon tube from UAT or hopper outlet to 4mm pump inlet tube.

Position “Y” connector close to valve inlets and connect pump outlet to Y inlet with 3mm tube. If you prefer to fit a manual fuel shutoff**, fit it in this fuel pressure line, not in the pump suction side.

(**Accessory available from Wren).

Connect “Y” outlets to each valve with 3mm tube.

Connect one valve output to engine fuel pipe (clear) with 3mm tube.

Connect the other valve output to the engine burner pipe (green) with 3mm tube.

Quick start installation - electrical:

Refer to this picture of the ECU for plug locations.

Plug burner valve to the 2-pin socket marked as “Gas valve” on ECU (see top left).

Plug engine fuel valve to adjacent 2-pin socket marked “Fuel valve” (extreme top left), note – this label is on side of ECU.

Plug in the receiver throttle signal wire from receiver to the plug marked “Throttle input” (see bottom right) – note brown wire = brown spot on ECU.

Plug in the engine rpm sensor to the 3-pin plug marked “RPM sensor” (bottom right) orientation as above.
Plug in the engine temperature probe to the 3-pin plug marked “Thermocouple” (bottom right).
Plug in the glow/starter cable from the engine, using extension if fitted, (top right).
Plug in the battery/pump cable (top left). Leave the battery end unconnected at this stage.
Plug in the data terminal (bottom left). A standard servo type extension cable can be fitted to the model to allow convenient access, if required.

You are now at the stage to run the engine.

*It is assumed the heli engine is correctly installed and rotors fitted ready to fly. If you just want to check the engine is able to start and it is installed but not fitted with rotors then you can do a start test but you must terminate this by doing stick-down, trim down, before the engine reaches idle at 55,000rpm.*

*If the engine is not fitted to the airframe do not try to connect it up and attempt to start it. The hazards are too great.*

**Setting up to run engine:**

**Fire Extinguisher**

Equip yourself with a fire extinguisher whenever you are planning to run your engine. The best extinguisher for our purposes is the Carbon Dioxide (CO$_2$). Use of dry powder, foam or water based extinguishers will cause serious damage to the engine and should only be used as a last resort. If you have a helper who holds the extinguisher always brief them what to do and where to point the extinguisher. You should be the one to decide if the extinguisher is to be used, and where.

Position fire extinguisher – if you get into trouble place trim down, stick down immediately to halt the start. Then energise the starter by raising the stick to full in blips to spin the engine up to clear. A little tiny flame is not a concern but big ones are.

*If you have an obvious fire, position CO2 extinguisher nozzle at engine intake and use short bursts to put out – do NOT point into the exhaust.*

**In Case of Emergency**

If you are unfortunate to have an engine problem, which results in an engine fire or excessive flaming in the exhaust pipe or fuselage, shut the engine down immediately by lowering stick and trim to zero. This will initiate the cool-down sequence on the ECU if the engine had reached idle. If the engine had not reached idle then reset the ECU by turning it off then on again, leave trim down and raise the throttle stick. This will force the starter on to cool the engine. Do not waste time doing this if you have a fire in progress though – put stick and trim to off and get the extinguisher at the intake quickly.

Never attempt to restart an engine, which has been involved in a fire without a thorough and detailed examination and investigation to confirm the integrity of all pipe-work and fittings and associated electrical wiring. If there are any doubts about the serviceability of the engine and its accessories following such an incident or accidental crash damage the engine must be examined and serviced by Wren Turbines Ltd or their appointed service agent.
**Area Clear?**
Select a clear area for running – keep clear of areas with loose leaves, sand or other debris that could be picked up or drawn towards the rotors and intake.

Turn on the receiver and verify the screen shows a reading.

Using the up “^” arrow enter the 3rd screen and enter the “RADIO” menu and perform the transmitter setup, if not already completed.

Connect the charged 2-cell LiPo battery. Turn on fuel if you have fitted a shutoff tap between pump and valves (preferred position).

Ensure trim and stick are at zero. Enter “INFO” menu and go down the entries until you get to “test” functions. Find “Test/Prime Pump”. Press “On” button to turn on fuel pump and watch fuel travel along from the tank to the engine. Press “Off” to stop.

Go further down “INFO” menu to “Prime Burner On Off”. Press “On” button and watch fuel travel to engine, then press “Off” to stop. Do not prime longer as you risk pouring fuel into the engine which will cause a flaming start. Small bubbles in the pipes at this stage will not prevent a start, just delay it or make it a little longer.

You should not prime the pump again unless you have completely drained the fuel system.

Confirm the battery is freshly charged and connected up. Go into the 2nd screen of the display where you will see the battery voltage indicated – confirm you have 8.2v or more to indicate a charged LiPo.

Go back to the opening screen on the display.

Confirm there is an ambient temperature reading on the HDT.

**Starting the engine**

Display shows “Trim Low”

To initiate the start, raise trim to full, (blue led in ECU lights and screen shows “Ready”). Place stick to full and back down quickly. (Holding the stick at full will spin engine at full power – can be used to cool down from a previous hot start or run)

Starter will spin engine briefly and then power igniter (screen shows “Glow Test” then “Burner On”).

[To initiate start without spinning engine raise trim to full, raise stick half way and back down]

Igniter will heat and after some seconds starter will spin engine slowly, pump will turn on slowly, igniter valve ticking. If pump does not come on raise “pump power ignition kero” until it does.

You should hear a gentle plop and combustion starting in the engine and temperature rise on the display. (Screen shows “Preheat”).

After some seconds engine speed and temp’ will increase, valve pulsing will speed up and the main fuel valve begin to open and engine begins accelerating past 15krpm, (HDT shows “Switchover” then “Fuel Ramp”). If engine flames out at switchover, increase “pump start point” until it continues. (Sometimes needs to be “40” or more).
If the engine slows down or makes smoke at switchover but keeps going, increase the value for "engine min flow" as the flow is not quite high enough to make a successful switchover.

At the end of “switchover”, burner turns off at around 20,000rpm, and “fuel ramp” begins.

Engine continues accelerating and starter turns off as it passes 30,000rpm.

(At this point if you have no rotors fitted and are just doing a start test, you must terminate here - trim down to stop)

The gearbox output shaft may start spinning after about 20k upwards, so be ready for this. If the engine slows below 30,000rpm at this time the starter will automatically come back on to bring the speed back towards 32,000rpm. The clutch should be disengaged at this point but may be dragging enough to exert some torque to the rotors – be ready for this. If it becomes too much then shut down the engine immediately by moving trim to off.

Engine arrives at 55,000rpm - idle, (screen shows “Running”). You now have control of engine via throttle stick.

In a helicopter installation starts are usually carried out without the display plugged in, due to the hazard from the rotor blades, but providing the engine is run gently, test starts and low power runs can be carried out with head loaders in position of the regular rotor blades. *Watch out for the tail rotor in this instance.*

Once the engine is running, leave it idling for 30seconds or so to allow a flow of lubrication to be established to the gearbox before throttling up. You should see fuel travelling along the lubrication tube to the gearbox in regular droplets.

*At any time the start can be terminated by lowering stick and trim to zero. The throttle stick can then be used to switch the starter to clear/cool the engine.*

If this is your first flight test, ease the throttle stick forward gently at first (no rapid slams) to allow the clutch to start to grab and then hold while the transmission picks up. Be aware of the swing of the tail and be ready to correct for this. As you advance the throttle you will feel the heli become light on its skids and this is the point to ask yourself if the rotor speed looks about right. If the pitch is coming in too fast you might need to stop and adjust your transmitter to raise the throttle curve points, or to drop the pitch curve downwards. Either way, at the point of lift-off the rotor should be going plenty fast enough to ensure enough tail rotor power and a stable rotor plane. There is no point going further if this is not right.

The turbine power increases rapidly as the rpms rise upwards so do not try to fly on too low an engine rpm or rotor speed. Once in the hover the throttle curve will be shallow as only a small increase in throttle will give a good increase in torque for the rotors. Take your time and tune the settings carefully. Always land and throttle down to idle or stop, before making any adjustments.

If you use a throttle-hold switch, you may need to slightly increase the acceleration / deceleration period setting (in “RUN” menu) as the ECU is set up to follow a transmitter stick throttle command whereas a throttle-hold is an instant up/down control. This rapid control can sometimes cause the engine to flameout when switched down to idle. The longer deceleration time has little effect during flying but should eliminate any problem.
**After running**

After a test start, lower stick and trim to zero for cooling.

After landing from a flight, leave the engine for 30 seconds at idle for temperatures to stabilise before returning the trim to off to shut down the engine.

ECU will spin engine in short bursts until the temp reading goes below 100°C where it will stop. If temp rises above 100°C again ECU will spin the engine again until below 100°C.

Once cooling is complete display shows “Stop”.

The engine cannot be re-started until the radio has been turned off and back on again to reset the ECU.

You can turn off receiver and transmitter and disconnect LiPo battery, if this is the last run for a while, or you need to recharge.

*Never recharge a LiPo whilst installed in a model.*

**Setting the throttle curve**

If you have not already set the pitch curves for the model, a good starting point for hovering and circuits is:

- **Low Stick**: 3-4 degrees of pitch
- **Mid Stick**: 5-6 degrees of pitch
- **High Stick**: 10 degrees of pitch

You can fine tune these later on to suit the model and achieve the desired feel.

Before we go into how to set up the throttle curve for our turbine helicopter, we need to remember that turbine engines respond to throttle changes in a different way from their IC counterparts. Whereas an IC engine will speed up and slow down relatively quickly, a turbine engine takes longer to make RPM changes at the low end of the throttle range but much faster at the high end, so your throttle curve needs to reflect this. The curve should be fairly flat with no sudden changes of angle.

A good starting point to set up a throttle curve is to set an initial curve like this.

- **Low Stick**: 0%
- **Mid Stick**: 60%
- **High Stick**: 100%

For most turbine flyers a peak preset turbine speed of 175,000 RPM is more than sufficient, so leave your turbine ECU set to this speed for now. In checks on ECU’s on engines in for service we find most flyers actually only run their engine at around 160krpm maximum even when set for 175k. remember to actually run at 175k your throttle stick would have to be asking for 100% throttle – not often with a heli as you soon run out of sky!

Most modern computer radios give 5 throttle points, so there is another value either side of the mid stick position. You can set these points quite closely to the mid stick value. Set these provisionally at 50% at the ¼ stick position and 70% at the ¾ stick position. We'll come back to this in a minute.
These figures give us our starting point. The best option now is to fly the model and see what sort of head speed the 60% throttle will give at hover point. At mid stick the helicopter should be hovering with a comfortable amount of head speed. The right amount will both sound nice and will make the model feel good in the hover.

You may find that the head speed is low and that the model will only just take off. It will feel rather dead and sluggish and you will be able to see and hear that the rotors are turning slowly. If this is the case, increase the mid stick throttle percentage until you are happy with the hover. Then change the ¼ and ¾ stick points by a corresponding amount. For example, if you find that 70% is correct in the hover, you will need to change the ¼ and ¾ positions to 60% and 80%. You can fine tune all these positions until the model flies the way you like it.

If you are using a computer radio with graphics you will see that the curve on the screen is quite shallow. This is a good thing. Small collective pitch changes to control the model's height have little or no effect on the core engine speed. There is a large amount of power available and modest changes in headspeed have no effect on the available power because the head is not connected directly to the engine as with an IC engine. With an IC model, if you slow down the head you also slow down the engine and the engine then produces less power. This never happens with a two stage turbine. This is difficult to explain but when you start flying the helicopter you will understand what we mean.

A lot of helicopter setting up comes back to how the model looks and feels in flight. If it doesn't sound right then it probably isn't. Remember you only need modest RPM's on the rotor head to fly, 1600~2000rpm is about right with 690mm main blades. Less is needed with 700mm+ blades. Try to allow the rotors to run freely with gentle pitch and plenty of rpms, too much pitch and it will become twitchy and bog down.

Stunt modes are very similar but you need more rotor energy for the snappy manoeuvres so you might dial in a higher max rpm setting to the ECU to raise your head speed a little. Raising the engine speed at the same time as increasing rotor pitch often means the rotor speed remains the same and users find that talk of governors proves unnecessary in practice.

Once you have the RPM set at hover you can alter the other points along the curve to provide that same RPM throughout the collective pitch range. Remember as the rotor pitch goes through 0 degrees you will not need as much power to turn the rotors and so the throttle curve will be lower at that point.

An optical tachometer is a worthwhile investment. It is a valuable tool to have because it stops all the guesswork – don't try to hold it yourself while flying though!.

**3D Flying with a turbine**

While a 44H powered turbine heli’ is capable of some truly amazing 3D flying it may not match the snappy up/down performance of its smaller IC counterparts but with a steady high power to the engine it can respond exceptionally quickly to the throttle and despite the inevitable higher all-up weight it is able to pull superb 3D.

Some models will not take to kindly to “stick banging” manoeuvres, such as elevator tic-tocs, where a lot of up and down elevator is used at the same time as violent pitch changes but turbine heli’s can manage it with its massive power reserve which will take your breath away. There is more than enough power to do these manoeuvres but the weight imposes excessive loads on the airframe and servos so do not expect “hobby level” parts to last like the “competition” or professional class components in this application. Do not skimp on the mechanicals, this is serious application and you will be collecting the pieces if you
economise and push it too hard. The harder you push your engine the more looking after and service support you will require as the engine and 2nd stage will be running hotter.

Watch the tail rotor rpms. It is easy to overspeed the tail and burst it when unloading the main rotor after a hefty dose of power so use the best you can get and set up carefully.

The best way to determine what is achievable is to fly the model. The model may be nose heavy with the engine out front but you can offset this with the battery over the tailboom, and it’s not hard to get a good overall balance, you can feel this when you are flying. You will get a feel for what the model is capable of as you become more experienced with it.

**Above all, enjoy and be careful.**
**Default settings used in ECU.**

A Wren supplied kerostart engine will already be adjusted for optimum ECU and pumps settings and should need little or no attention, so do not fiddle with the settings.

As the fuel pump wears it may be necessary to adjust settings – see later.

Please note, no two installations will be truly identical so **do not** swap settings with a colleague with a similar engine as they will most likely not be compatible.

If the fuel pump is replaced, new settings may be required as no two pumps have precisely the same characteristics.

A problems checksheet follows in the next couple of pages. It lists common faults and the likely cures and hopefully will solve your problem quickly.

Please use the checksheet before calling us – it is there to help you to save time trouble and expense. The most regular problem is failing battery voltage under load, so check this first.

If you find something not covered then of course mail us with a description and we will try to help you: [info@wrenturbines.co.uk](mailto:info@wrenturbines.co.uk)

Please note, we can only help users with a Wren engine.

**ECU default values and adjusted settings:** (write in your own settings for your record:)

<table>
<thead>
<tr>
<th>Item:</th>
<th>Wren default:</th>
<th>My supplied settings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump start point</td>
<td>025 to 040</td>
<td></td>
</tr>
<tr>
<td>Pump start ramp</td>
<td>004</td>
<td>004</td>
</tr>
<tr>
<td>Glow power</td>
<td>6.7v</td>
<td>6.7v</td>
</tr>
<tr>
<td>Low battery volts</td>
<td>6.0v</td>
<td>6.0v</td>
</tr>
<tr>
<td>Starter power at ignition</td>
<td>060</td>
<td>060</td>
</tr>
<tr>
<td>Starter power at fuel ramp</td>
<td>070</td>
<td>070</td>
</tr>
<tr>
<td>RPM point 100% starter power</td>
<td>25k</td>
<td>25k</td>
</tr>
<tr>
<td>RPM starter off</td>
<td>30k</td>
<td>30k</td>
</tr>
<tr>
<td>RPM reconnect starter</td>
<td>27k</td>
<td>27k</td>
</tr>
<tr>
<td>RPM Ignition kero</td>
<td>7k</td>
<td>7k</td>
</tr>
<tr>
<td>Pump power ignition kero</td>
<td>025 to 040</td>
<td></td>
</tr>
<tr>
<td>Engine min flow %</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>EGT end preheat ºC</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>RPM preheat kero</td>
<td>12k</td>
<td>12k</td>
</tr>
</tbody>
</table>
**ECU Default Settings, cont.**  

<table>
<thead>
<tr>
<th></th>
<th>Wren defaults:</th>
<th>My supplied settings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPM fuel ramp kero</td>
<td>20k</td>
<td>20k</td>
</tr>
<tr>
<td>Preheat fuel</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Ignition timeout sec's</td>
<td>24.5</td>
<td>24.5</td>
</tr>
</tbody>
</table>

*Items highlighted adjusted for fine tuning*

**PLEASE DO NOT TWIDDLE SETTINGS WITHOUT REASON**

### Problem Checklist

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Problem</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No reading on ECU display unit</td>
<td>RX not switched on or RX battery discharged</td>
<td>Verify connection and charge if necessary</td>
</tr>
<tr>
<td></td>
<td>Display not connected properly</td>
<td>Ensure that display is connected and that the plug ‘clicks’ into place</td>
</tr>
<tr>
<td></td>
<td>Display malfunction</td>
<td>Contact Wren</td>
</tr>
<tr>
<td>Transmitter stick down/trim up reads “StickLo”</td>
<td>Throttle channel needs reversing,</td>
<td>Reverse channel on Tx (most Futaba’s need this)</td>
</tr>
<tr>
<td></td>
<td>Thermocouple not connected to ECU</td>
<td>Plug in</td>
</tr>
<tr>
<td></td>
<td>Thermocouple plug inserted wrong way round</td>
<td>Ensure connector matches the label on the ECU</td>
</tr>
<tr>
<td>Temp’ reading shows lower or negative figure after ignition</td>
<td>Rpm sensor plug inserted incorrectly</td>
<td>Ensure connector matches the label on the ECU</td>
</tr>
<tr>
<td></td>
<td>Rpm sensor lead broken/chafed</td>
<td>Contact Wren and remove source of chafing</td>
</tr>
<tr>
<td></td>
<td>Rpm sensor malfunction</td>
<td>Contact Wren</td>
</tr>
<tr>
<td>No rpm indicated when engine is spun</td>
<td>No fuel reaching burner</td>
<td>Verify connections to valve and ECU</td>
</tr>
<tr>
<td></td>
<td>Pump not turning</td>
<td>Increase “pump power ignition kero”</td>
</tr>
<tr>
<td>Burner will not ignite</td>
<td>Burner valve not opening</td>
<td>Check connections</td>
</tr>
<tr>
<td></td>
<td>ECU battery low (often)</td>
<td>Charge</td>
</tr>
<tr>
<td></td>
<td>Burner blocked with carbon (very rare)</td>
<td>Return burner for burner service / replace</td>
</tr>
<tr>
<td></td>
<td>Glow power insufficient (rare)</td>
<td>Go into “Glow plug power” screen on ECU display and increase by 0.2v</td>
</tr>
<tr>
<td>ECU shows “GlowBad” after initiation of start</td>
<td>Burner element bad connection or open circuit</td>
<td>Check connections and burner continuity. Replace burner if open circuit.</td>
</tr>
</tbody>
</table>
Sometimes the ECU deadband at the trim-up, stick-low position is too small and the engine idle is raised slightly or the engine will not properly come down to idle.

To solve this, during the transmitter setup where you are asked for stick low, trim up, add in two clicks of throttle stick as well and then press “+” to enter the setting. This will increase the deadband at the idle point and should resolve the high idle issue.

**If engine sometimes does not complete a 1st start, raise the “pump start point” by 1 point.

When retrying a start for any reason, wait 5-10 minutes for the engine to cool. The ECU uses the engine temperature to progress the different start stages so if it begins whilst still hot it may miss out certain parts.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Problem</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel pump not running</td>
<td>Pump not connected</td>
<td>Check wiring</td>
</tr>
<tr>
<td>ECU display not showing “Ready”</td>
<td></td>
<td>See “Starting the engine”</td>
</tr>
<tr>
<td>Pump jammed with foreign object</td>
<td></td>
<td>Investigate operation</td>
</tr>
<tr>
<td>No or little temp’ rise on ignition</td>
<td>Insufficient burner fuel</td>
<td>Increase “pump power ignition kero”</td>
</tr>
<tr>
<td>Temp’ probe not properly inserted into interstage</td>
<td></td>
<td>Insert 6mm</td>
</tr>
<tr>
<td>Pump runs but no fuel delivered</td>
<td>Fuel not reaching tank pick-up</td>
<td>Check clunk for blockage. Ensure fuel like is not kinked</td>
</tr>
<tr>
<td>Pump fault</td>
<td></td>
<td>Contact Wren</td>
</tr>
<tr>
<td>Burner solenoid not opening</td>
<td></td>
<td>Check wiring to ECU</td>
</tr>
<tr>
<td>No or little rpm increase as fuel enters</td>
<td>Insufficient revs on starter motor</td>
<td>Recharge ECU battery</td>
</tr>
<tr>
<td>Clutch slipping</td>
<td></td>
<td>Replace O-ring</td>
</tr>
<tr>
<td>Air in fuel line</td>
<td></td>
<td>Air will disappear after several seconds</td>
</tr>
</tbody>
</table>

**Trim down/shut off fuel & gas immediately**

- Residual fuel in engine
- There was air in fuel system
- Insufficient revs on starter
- Pump running too fast at “switchover” or “fuel ramp”
- ECU settings changed
- Engine malfunction

- Spin engine “dry” for 10 seconds to clear. (remove fuel solenoid plug from ECU)
- Restart after 5 minutes cooling
- Recharge ECU battery
- Reduce “pump start point”
- Return to original settings
- Contact Wren

- Normal problem until ECU settles down
- * see note below.
- ECU will correct itself and settle down

*Sometimes the ECU deadband at the trim-up, stick-low position is too small and the engine idle is raised slightly or the engine will not properly come down to idle.*
Helicopter engines which are mounted in the cabin area do not lend themselves easily to scale installations. However, providing the airframe is large enough it is not impossible. Points to bear in mind are that the turbine inlet should have a supply of fresh, cold air that has not been heated by passing over the exhaust system and the gearbox. It is possible to duct the exhausts to a scale position and this has little effect on the engine’s performance but the ducts will be much larger than scale size. Scale helicopters often benefit from a constant speed rotor head. A special version of the ECU with this facility is under development, but good results have been achieved with the Model Avionics Throttle Jockey Pro.

**Maintenance**

If the engine is run at a modest speed (up to 175k rpm) in clean conditions it will have a very long life. 50 hours is the recommended interval for servicing and changing engine bearings.

If the engine is run at higher speeds up to 195k or in dusty or sandy conditions the service interval will be shorter at approx 25 hours though this cannot easily be predetermined. Engine temperatures and bearing noise should be carefully monitored to warn of any possible problem.

The gearbox is lubricated by a fuel/air mixture fed from the front of the engine. No maintenance is required. The helicopter airframe rotating components must be well balanced. Out of balance forces from the rotor shaft and blades can cause rapid fatigue damage to the engine and we will not warranty the engine for this. Ensure the engine and transmission are aligned accurately within the frames.

Always report back to Wren if you are worried about any unusual noises, especially new noises arising since a hard landing, etc.
Starter noises
A screech coming from the engine during starting may indicate the O-ring in the starter is worn. It’s easy to replace so contact Wren for a spare. Pull off the black cap first, then the three grub screws (1.5mm hex key) around the starter nose should be slackened three turns to allow the starter to be pulled free. The worn O-ring can be seen and picked out with a pin and a new one popped in. Replace the starter back all the way in and then pull it back 1.5mm (1/16”) to allow for clutch clearance. If you have some BLUE “Loctite” or similar thread locking compound, a small dab on each grub screw will ensure they do not loosen. DO NOT use green Loctite anywhere, it will be impossible to remove. Then gently and evenly retighten the grub screws and replace the black cap.

Be aware the starter motor has magnets inside its case and if you over tighten the grub screws you will hear a sickening crunch as the magnets break, so be gentle, nip only.

Storage
The unit does not need any special attention after running beyond those indicated. For storage some areas should be noted:

Always remove or disconnect the LiPo at end of the flying session. Charging must always be done with the LiPo disconnected but the ECU will draw a few milliamps even in the off state and after a few weeks this can drain a LiPo to nothing and ruin it permanently.

On shutdown, oil will remain in the gearbox for the following run so it is not recommended you hang the heli on the wall with its nose at the bottom as the lube can run out into the exhaust area and can cause a large cloud of smoke on the next start or a mess in your store. If you absolutely have to hang the heli on a wall, keep it nose up. Horizontal storage is best if you have room.

Place a small polythene bag over the vent on the fuel tank to prevent your workshop dust getting into the fuel tank and clogging your expensive filters. Use a plastic bag rather than a solid plug as it will still allow for expansion in the tank if required.

When putting away for longer than one month, fuel pump should be disconnected from the fuel system and filled with clean, neat oil and the pipes sealed. You can use the pump test function on the ECU to drive it. This will stop any internal corrosion starting. To reuse, simply drain out the oil and flush through with clean fuel and then reconnect to the fuel system.


DISCLAIMER
Gas turbine engines are a sophisticated piece of machinery. Care should be taken at all times when using these engines. They should only be operated by those with the appropriate skills and knowledge to do so. Incorrect operation or misuse can cause damage to property and bodily harm to operators, spectators and animals. Wren Turbines Limited accepts no liability for any kind of damage which may occur.

Wren Turbines Limited assumes no responsibility for any errors contained in this document and is not liable for any damages resulting from such errors.

The use of this equipment outside Radio Control applications is forbidden, especially those that power vehicles that carry people