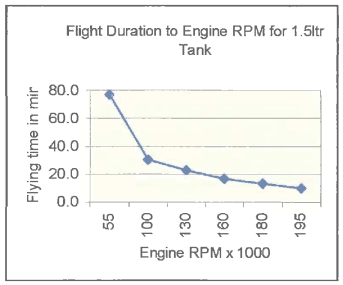
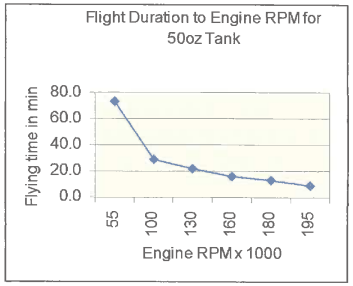
Hopper Tanks and UAT's
Hopper tanks and UAT's (originally the Ultimate Air Trap from BVM Models) are a popular choice and can help with the consistency of fuel supply – especially on aerobatic models. The standard hopper tank is simply a small capacity fuel tank which is fully sealed and has a single fuel-in pipe and a fuel outlet positioned centrally so it can pull fuel from any attitude the plane finds itself in. The UAT is similar 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 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 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.

UAT's are helpful, but the guide still applies – keep the tank capacity well above the flight time requirement so the tank clunk is not chasing the last dregs of fuel around at the bottom of the tank.

Flight Time Endurance
How long a plane can fly on a given quantity of fuel is only of academic interest to most but it does give an idea where in the flight envelope is the most economical for those with an eye on the longest flight times!





Looking at the graph above, a steady 100,000rpm on the engine equates to about 25N (5-1/2lbs) thrust from the propeller, which is enough to keep a plane of 10-15kg (22-33lb) aloft at reasonable altitude. In this case you could expect over half an hours flying on the recommended fuel tank.

Note that for most aircraft, though it is perfectly feasible to anticipate a flight of over half an hour of gentle flying, this would not only be a true test of piloting but also of the on-board ECU battery (LiPo) which may be marginal if not fully charged before take-off. If you plan to attempt such marathon flights we recommend a larger capacity LiPo for the ECU battery, possibly also a larger receiver battery too (also a well charged transmitter), so there are no embarassing "quiet" moments when the engine slows and dies and you have to land with fuel remaining but no engine.

You can see where the engines reputation as being "stingy" with fuel comes from.

Installation

DO's:

Ensure adequate supply of cold air to the engine intake behind the firewall. This must be an independent supply and isolated from the area in front of the firewall which can get warm in operation. It is good practice to fit a fine wire mesh at the entrance of this area to prevent buildup of grass etc from clogging the engine intake. An ideal material for this is the fine high quality stainless mesh available from Wren Turbines at modest cost.

Ensure adequate ventilation of the stagnant area in front of the firewall to prevent build-up of heat around the exhaust sections from distorting the fuselage or cowling or affecting the paint finish of same.

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

Engine should be mounted using the six bolt radial-mounting. No other means of mounting the engine is allowed.

Ensure the engine is firmly secured to the firewall using six M3 bolts, and captive nuts to prevent pulling through.

Any up/down or side thrust should ideally be added to the firewall and not simply a couple of washers under the engine mounting which can cause distortion of the mount and potential alignment issues within the engine.

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

The glow plug and lubrication feed pipe must be positioned upwards – see the cutout template at back of manual. This is to ensure correct operation of the engine internal lubrication system during start-up. Inverted flight manoeuvres do not affect the lube system during normal running.

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 be mounted with the spindle in the vertical position with the motor uppermost and the black cap downwards. In the event of any fuel seeping from the pump this will not pass through the electric motor. 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 (CofG) of the model as possible. This will minimise the CofG 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 Ltd.

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 servo extension. Such 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 or an approved 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 final fuel filter is pre-fitted to the engine in the fuel line just before the green cover. To disconnect the fuel line from the engine, disconnect at the quick release connector at fuel filter.

Lubrication Oil.
This fuel requires an approved lubrication oil mixed at the rate of **5% oil** to **95% fuel**. Note this is more than is normally recommended for Wren engines as it also has to provide lubrication to the gearbox. Using a lower oil percentage than this can cause early failure of the gearbox and/or bearings.

If fuel is already mixed to the previous 2.5% then simply add a similar additional quantity of oil to increase to the 5% required. All Wren engines can run with 5% oil without harm if you want to keep just one mix for all your engines.

All pipe-work used must be of the type supplied by Wren Turbines.

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 (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.

DON'Ts.

Never mount the engine using woodscrews – it is impossible to ensure they cannot loosen or pull through from the firewall.

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.

The engine must never be run with the gas pipe open to atmosphere.

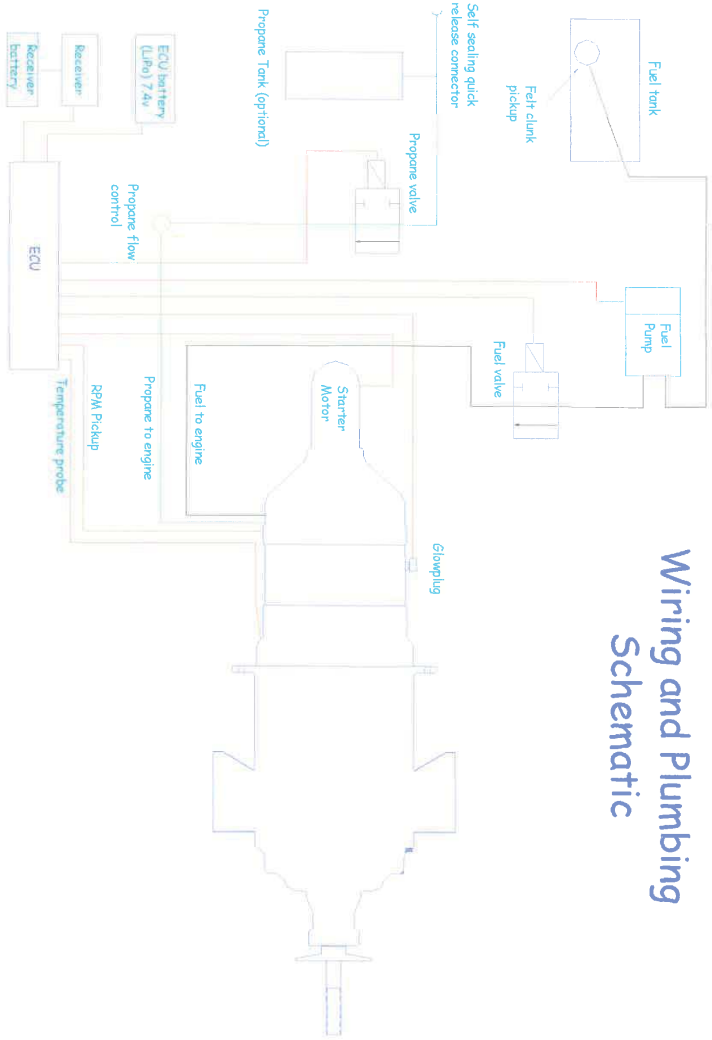
Do not install filters in the feed (suction) line from the fuel tank to the fuel pump. This is known to cause aeration of the fuel and flow disturbances resulting in stoppages.

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.

Never break the fuel line after the filter as this can allow debris to enter the engine fuel system which can cause severe damage to bearings and combustion system.

Do not extend the rpm pickup or temp probe wires by cutting and soldering in extra lengths, as this renders them non-standard and historically has been a regular source of failures.

Wiring and Plumbing Schematic



Installation – System Components

The airframe should be one in which an I/C engine was the intended powerplant as the engine needs a secure firewall to attach to. It is difficult to be specific as the exact procedure for mounting but a good place to start is to examine the original intended I/C engine install for any information on the requirements for positioning the thrust line. If you are converting an aircraft which had an I/C engine already then you may need to install a sub-firewall to take the engine. See the full-size view at the end of the manual for positioning of the unit with respect to a known propellor backplate point.

Using the fuselage plan (if available) or from your own judgement, mark the engine centre point on the firewall with a line top to bottom and side to side. Cut out one of the mounting templates from the back of this manual and align the template to the cross lines already marked in. Use some double-sided sticky tape or simply glue the template in place and use a drill and narrow saw to cut out the opening for the main body and the two "ears" to clear the glowplug and lubrication fitting on the engine.

Offer up the engine unit to the hole and mark any tight spots. Remove the engine and with a coarse file or modelling knife ease the opening. Be careful not to injure the delicate lubrication fitting on the engine or damage the lubrication pipe – the clear 3mm tube that connects to the gearbox whilst offering up and removing the engine.

Once the engine is fitting well, you can now drill the six 3mm (1/8") mounting holes marked on the template and fit captive nuts to the reverse side of the firewall.

An opening needs to be cut into the bottom of the fuselage or the lower half of the firewall where a plane has a chin inlet (see left), to allow cool air to reach the engine intake. This should be an absolute minimum of 2500^2 mm - 50mm (2") square, more is better for the engine.

If you have made the opening in the lower firewall then it must be isolated from the exhaust and gearbox section using a false bottom. This is ideally positioned in the lower section of the cowl, where this is removeable.

This is by far the preferred option as it is easy to position and mark the exhaust cutouts.

The chin inlet allows easy passage for cooling air to reach the engine intake by passing under the partition.

In flight a degree of ram effect may help the engine too!

After fuelproofing the engine area the engine unit can now be offered up and secured into place.

If you don't have the opportunity or space for a chin inlet then a "cheat" inlet for the engine air can be made in the lower fuselage (see above right). A cutout has been made and covered in a fine mesh. At a distance or in flight it is not noticeable. The engine cowl needs trimming to fit the exhaust system. Try to leave about 6mm (1/4") all round it to prevent any heat cracking or spoiling of the paint finish.

Refer to the Wiring and Services Schematic on page 22 to confirm the order and location of all the ancilliaries, the fitting of which follows.

Fuel Pump

The fuel pump should be mounted close to the fuel tank to ensure only a short pipe run is needed. Note the direction of flow on the pump. Fit it with the black cap upwards if possible and with the pipes accessible – just in case!

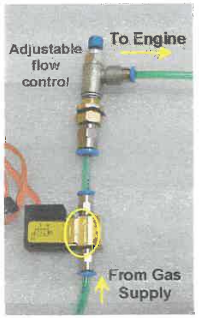
Fuel valve

The fuel valve should be positioned fairly close to the pump but this is less critical. Note the flow direction is marked on the valve.

The pressure outlet from the fuel valve then leads to the engine fuel filter and on into the engine.

Only make and break the engine fuel line at the quick-release connection on the fuel filter. This keeps the engine protected from dirt getting into the system – but keep everything spotlessly clean anyway.

Propane System



The propane supply is either plugged in externally or contained in a small canister on-board the aircraft – see later. For either installation the control side is the same.

The propane supply feeds into the inlet of the propane valve, note the direction arrow. The output of the propane valve feeds into the bottom of an adjustable flow control and the output of this feeds the green propane pipe to the engine. It is important the flow should be in this direction as the flow control only works in this direction.

The flow control is preset at the point of engine test so should not need any, or at least only minor adjusting for first trials.

The lower part of the flow control has a brass bulkhead fitting screwed on. This enables you to fit it to a mounting point in the aircraft where it is externally accessible in case of required adjustment. The fitting can then be refitted after mounting the brass adapter. Do be careful to eliminate any leakage from the threads.

On-Board Propane Supply

If you plan to feed the propane from an on-board tank, mount this vertically with the connector at the top. This is to prevent the possibility of liquid propane finding its way into the system which can cause aggressive and uncontrolled surging starts and local freezing of the flow control components. The filling side of the tank has a one-way valve in it. The outlet is plain and should be fitted with a suitable length of tube to the propane valve.

The tank only requires to be partially filled and needs to be liquid. Use the self-sealing quick-release connector to connect the supply to the aircraft. The main body part of the quick release is fitted with a short tube and then connected to the one-way valve. This valve protects against leakage in case the quick release connector does not seal properly.

With most canisters liquid propane can be obtained by first connecting up, then inverting the can and then turning on the supply tap. Before doing this always ensure it is safe to do so – no naked flames, no smoking in the vicinity and never do this indoors. After filling the connector can be released and propane will remain sealed in the tank.

Once the tap is opened flow can then be seen to move along the pipe to the tank. Always wait a few minutes for the liquid to settle and clear the supply pipes before try for an engine start.

Brass connectors together- propane flows

Brass connectors apart- propane is sealed in

Off-Board Propane

If you plan to use off-board or external propane, then simply plug the external canister into the aircraft, using the quick release connector supplied.

The supply in this case must be gaseous only – no liquid propane. The gaseous supply is then fed directly to the propane valve and the outlet of the propane valve feeds the flow control as before.

Fuel Tank Clunk Pickup

A felt-type clunk is supplied for you to use for your fuel tank in case you need it.

A washer needs to be fitted before the felt part to stop it sliding onto the part where the tube goes on.

UAT/Hopper Tank

If you plan to fit a UAT (Ultimate Air Trap from BVM Models) or a hopper tank then position this close to the tank outlet and plumb in using the largest tube that can be fitted. A length of 3.1mm (1/8") soft yellow Tygon tube is included in the package and this is ideal. This allows the greatest flow possible and minimises the chances of pulling a vacuum or starting an air leak into the fuel system. Note – it is possible for air leaks to appear that are so small as to not let fuel out and leave a trace, but still cause troubles.

Making an airtight joint to the fuel pump

Make a similar secure connection between the UAT/hopper to the fuel pump and similarly keep this pipe run as short as you can. If the Tygon is not such a firm fit onto the pump then push on a 12mm (½") length of 4mm tube onto the barb first and then push the Tygon on over this – this should be really tight and very leak free. Just adding a tie-wrap onto a loose pipe will not make a secure joint as it forces the tube into a "D" shape and air can leak in through the corners of the "D" – use the short length of 4mm tube, it works every time. If later you need to remake the joint simply cut the last bit off the Tygon and refit it onto a fresh end to keep it tight.

Fuel pump to fuel valve and engine

The outlet of the fuel pump feeds the fuel valve directly - note the direction arrow on the valve. The outlet of the fuel valve feeds the engine fuel filter. This pipe run can be some distance without causing any problems as it is a pressure line. As before, if you have to remake any of these connections then it is a good idea to cut the last bit cleanly and remake the join. Keep all your pipes a little on the long side to enable you to do this.

ECU (Engine Control Unit)

Next, connect the propane and fuel valves to the ECU. The propane valve is plugged into the top connector and the fuel valve connects to the one below (see left). The green temperature probe cable (thermocouple) and RPM pickup are next to be inserted. Make sure that the colouring of the wires matches the picture on the ECU. It is very important that these are connected correctly in order for the ECU to function correctly.

The fuel pump and starter need to be joined to the ECU via their Multiplex connectors, these can only be connected in the correct order but you can check the wire colouring against the picture on the ECU.

Connect the signal lead from the ECU to the throttle channel on your receiver.

If required, the solenoid, RPM pickup and thermocouple wires can be extended with a standard servo extension lead. Those for JR radios are compatible with the ECUs connections.

NOTE: The wires leading to the pump, glowplug and starter are twisted together in order to reduce interference; do not attempt to untwist them.

Mounting the ECU
The ECU can be mounted in any accessible position – people often use a hook & loop type strip.

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.

Once the remainder of the servos are installed and tidied the ECU can be set up with your radio.

Set up ECU (Engine Control Unit)

The ECU supplied is a special version of the FADEC Autostart ECU by Gaspar Espiell. It is a reliable unit and is supplied programmed for the Wren44 TurboProp. The engine has already been set up and tested using the ECU and the fuel pump, so there is only the radio to setup to get the engine ready for running.

Confirm you have connected the ECU input to the throttle channel of your receiver and the ECU data terminal (display) is plugged into the ECU. 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 it would be advised to check if a switch on the transmitter has been allocated the function of "throttle cut" or "engine cut" which normally has the effect of producing the trim-down function. Check your radio manual for this before you start.

As the display does not photograph well we have reproduced the display readings as a green box.

Turn on the transmitter and receiver. The opening screen should show as below: (If the temp" probe is not connected it will show as 0'C). "T" = ambient temp' (shown as 15'C but will be whatever you have locally at the time).

```
Trim Low        T=015'C
RPM 00000       PW 000
```

Note there are four buttons along the bottom of the display (^ v - +). The two left buttons move to the different screens and the two right buttons are used to change the values stored.

Press the 2nd from left button (v) to scroll down the menus until you find the one showing :

```
Transmitter      yes
adjust
```

Press the right hand button (+) and the screen will change to:

```
Stick Up Trim Up
   (Full power)
```

On your transmitter, raise the throttle stick and trim to full. Ensure stick is firmly against the stop.

Now holding the stick against the stop, press the right button (+) to set the value into the ECU.

The screen will now change to:

```
Stick Down
Trim Down    (Stop)
```

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

The display should now change to:

```
Stick Down
Trim Up      (Idle)
```

Leaving the throttle stick in the minimum position, raise the throttle trim to the full up position or switch "Engine Cut" switch to off, and again press the right (+) button.

If you have done all steps correctly a blue LED will light up in the end of the ecu under the display plug, and the display will change to:

```
Acceleration
Delay 005
```

NB. The value for acceleration delay may be set other than shown – do not alter it.

Lower your throttle trim and the green light should turn off or go very dim. If it does not then you need to **reverse the throttle channel,** and repeat the radio set-up.

This completes your radio setup and should only need doing again if the radio settings are changed significantly or if you suspect the setup to have altered.

You will note there are many settings, which can be adjusted in the ECU. Please resist the temptation to change things as firstly this is unnecessary as they are preset 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.

```
Timer:          Tot:0000m
Last: 000s      Cy:000
```

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 ECU to the engine. These are then optimised to suit each engine. Do not change the values present in your ecu without referring back to Wren Turbines.

Max rpm	–	195,000rpm.
Idle rpm	–	55,000rpm.
Stop rpm	–	32,000rpm.
Start temp'	–	100'C.
Max temp'	–	848'C.
Acceleration delay	–	5-10.
Deceleration delay	–	10-30
Stability Delay	–	50.
Pump start point	–	Auto+1.
Pump Start Ramp –		006.
Glow plug power	–	32-36

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 interuptions 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 AIRCRAFT WITH THE FAILSAFE SET TO "HOLD".

Preparing the engine for running

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 propeller and intake.

Ensure the fuel tank is position well clear of the exhaust area and secured. The same applies to the starting gas canister.

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.

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 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 in quickly.

The extinguisher should then be positioned to discharge into the engine intake or the passage leading to the intake, or alongside the engine towards the exhaust. Do not point the extinguisher into the exhaust as this will surely carry hot gases back through the engine and into the aircraft and potentially cause more damage.

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.

Fuel
The engine is designed to run on a mixture of fuel and oil to a ratio of 95% fuel to 5% oil, ie 20:1.

The fuel recommended is standard Jet A1 kerosene, available from most airports, or paraffin used for greenhouses and available from most hardware stores.

Central heating oil, gasoline or methanol based fuels may not be used in this engine. Such fuel can cause severe damage to the combustion chamber components fitted to this engine.

The fuel needs to be carefully filtered before use to eliminate carrying over of solid particles or water into your fuel system.

Oil

The oil required is standard turbine oil available from Airports and jet suppliers.

Suitable turbine oils are:

Aeroshell 500	Exxon 2380
Mobil Jet Oil	Castrol TTS

Mix 50ml of oil for each 1Ltr of 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.

First running

Confirm that your engine mounting is secure and that your plane is properly restrained by a helper. Keep your ear defenders within easy reach – at high rpm the prop makes quite a lot of noise. Connect the starter propane connector to the propane line or fill the propane tank to about ½ full if you have on-board propane. Mix some clean filtered fuel with 5% oil and fill the tank.

Turn on the transmitter and receiver.

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 7.4v or more.

Go back to the opening screen on the display.

Confirm there is a temperature reading on the display.

Confirm your CO2 fire extinguisher is close at hand.

Ensure the running area is clear of onlookers.

Starting the engine

Ensure throttle stick and trim is set to down. Turn on transmitter then receiver if not already on. ECU screen should come on.

Set trim to up – confirm display shows "Ready".

Quickly raise throttle stick to full and back to off again, to initiate start. Do not touch the stick again until the engine is at idle or the start will be terminated.

You will hear the engine giving a short spin and "ignition" will show on display. The engine will slow down and the gas should be heard to light with a small "plop".

The display should show the temp' rising. If it is slow to do this abort the start and adjust the blue propane adjustable flow control.

Once over 100'C the display will read "FuelRamp" the pump will start to supply fuel.

Fuel should then be travelling along the feed pipe towards the engine and as soon as the fuel reaches the engine you will hear the engine note change. The engine and propeller will start to accelerate and the engine rpm will rise past 30,000rpm as shown on the display you may hear the starter disengage and continue accelerating up to idle, at around 55'000rpm. 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.

Once the engine is running, leave it idling for 30seconds or so to alow a flow of lubrication to be established to the gearbox before throttling up. When ready to shut off, leave the engine for 30 seconds at idle for temperatures to stabilise before returning the trim to off to shut down the engne. The ecu will then command a cooling cycle for the engine and you can hear this as a series of spin-ups of the starter as the temperature reduces. Once the engine has cooled it will stop cooling and you can shut down. Do not touch the throttle stick during cooling.

Things People Do or Don't

If you find the engine blows out the propane gas during the start, it means the fuel had not reached the engine. In this case, simply lower the radio trim to zero (which will terminate the start), wait for the engine to come to a halt (about 20seconds), raise the trim and go for another start. If the propane blows out again repeat again but use a little more propane by opening the blue adjustable flow control a little.

Batteries – a common problem with starting is a fading ECU battery. The engine does many starts on one charge and it is easy to forget to keep them topped up and a low battery can catch you out. Go into the 2nd screen in the ecu and do a start and watch the battery voltage. If it dips below about 7.2v it needs recharging.

Problem Checklist

Symptom	Problem	Action
No reading on ECU display unit	RX not switched on or RX battery discharged	Verify connection and charge if necessary
	Display not connected properly	Ensure that display is connected and that the plug 'clicks' into place
	Display malfunction	Contact Wren
	ECU problem	Contact Wren
Transmitter stick down/trim up reads "StickLo"	Throttle channel needs reversing,	Reverse channel on Tx (most Futaba's need this)
Temp' reading incorrect or "0"	Thermocouple not connected to ECU	Verify connection
	ECU problem	Contact Wren
	Thermocouple failure	Contact Wren
Temp' reading shows lower or negative figure when gas lit	Thermocouple plug inserted wrong way round	Ensure connector matches the label on the ECU
No rpm indicated when engine is spun	Rpm sensor plug inserted incorrectly	Ensure connector matches the label on the ECU
	Rpm sensor lead broken/chafed	Contact Wren and remove source of chafing
	Rpm sensor malfunction	Contact Wren
	ECU problem	Contact Wren
Gas will not ignite	Gas bottle empty/low/ very cold	Check gas flow by sound/smell, replace or warn as necessary
	Poor glow at plug	Check battery voltage
	Plug blown	Replace plug
	ECU battery low	Charge
	Glow element not exposed	Tease out with pin
	Glow power insufficient	Go into "Glow plug power" screen on ECU display and increase by 2 points
ECU shows "GlowBad"	Plug blown	Replace plug and check connections

Symptom	Problem	Action
Fuel pump not running	Pump not connected	Check wiring
	ECU display not showing "Ready	See "Starting the engine"
	Pump jammed with foreign object	Investigate operation
No or little temp' rise on gas lit	Insufficient gas supply	Increase flow/renew can
	Temp' probe not inserted into exhaust cone	Insert 3mm
Pump runs but no fuel delivered	Fuel not reaching tank pick-up	Check clunk for blockage. Ensure fuel like is not kinked
	Pump fault	Contact Wren
	Fuel solenoid not opening	Check wiring to ECU
No or little rpm increase as fuel enters	Insufficient revs on starter motor	Recharge ECU battery
	Clutch slipping	Replace O-ring
	Air in fuel line	Air will disappear after several seconds
Excessive flaming	**Trim down/shut off fuel & gas immediately**	
	Residual fuel in engine	Spin engine "dry" for 10 seconds to clear
	There was air in fuel system	Restart
	Insufficient revs on starter	Recharge ECU battery
	Starter motor burnt out/inoperative	Dealer replacement
	ECU settings changed from defaults	Return to defaults
	Engine malfunction	Return to dealer
Engine overshoots at idle	Normal problem until ECU settles down	
	Starting technique too slow	Practice
	Air in fuel line causes late but rapid start-up	ECU will correct itself and settle down
Engine slows or is stopped during start	"Overtemp'" is detected by ECU and shutdown if temp' has run over 850'C due to long hot start, low start battery or air in fuel line.	Cool off and restart
	Wild rpm reading	Interference to rpm pickup by electromagnetic device sited too close, find and move. Check that Starter/Glow wires are twisted.
Engine slows or stops during acceleration	Air in fuel line	Check tank system for air leaks/fuel flow problem
	Blocked FOD screen (if fitted)	Unblock
	Stick may not have been fully positioned on setup	Check TX setup
	Tank vent blocked preventing fuel being supplied	Unblock
	Incorrect positioning of Jet Pipe	Ensure that the jetpipe is concentric with the engine and 30mm from the end of the tail cone
Engine slows or stops in flight	Pump battery discharged	Recharge
	Clunk filter or fuel pipe blocked	Unblock
Engine stops in flight	Low fuel	Refuel
	Air in fuel system	Check tank system for leaks or blockages
	Bad connection at pump, pump battery or ECU	Check and solve
	Rpm or temp' sensor faulty or bad connections	Check and solve
	"Kill switch" operation insecure	Replace
	RX interference causing ECU shutdown	Find interference source and solve
Excessive/unusual noise or vibration	Engine out of balance due to foreign object ingestion	Return to dealer
Engine stops during deceleration	ECU not adjusting quickly enough to a freshly charged battery	Slowly cycle the engine from idle to full throttle and back to let the ECU calibrate itself
	Altered pump behaviour as a result of age and/or wear	Increase the "Deceleration delay" on the ECU by 5 points

Flying the Wren 44TurboProp

Flying a turbo-prop is very similar to flying a normal gas turbine. There is a slight lag in the acceleration from idle but higher up the rpm range the pickup is faster and less noticeable. It would be noticed that the propeller thrust comes in much earlier than on a thrust engine and less is needed to start a plane rolling for taxiing or manouvers. The 44 Turbo-Prop has an extremely quick acceleration even from idle and even when turning a large propeller and spinner there will be very little lag apparent.

Throttle Response Curve
The torque of a turbo-prop increases as a function of the engine case pressure increase. This occurs as an exponential curve meaning that the response curve steepens more rapidly as the rpm increases. The result of this is that half power in the form of propeller thrust actually occurs at about ¾ throttle stick and the remaining throttle comes in very quickly at the high end of the stick travel. This can make flying the unit very sensitive on the stick as only very small movements can result in large changes in output power.

Flyers might wish to program a throttle curve to reduce the response at the high end now that this function is standard on all computer radios. The following data may be useful in deciding a starting point for a suitable curve.

A typical thrust table is shown below for a 610x200 (24x8) 2-bladed propeller.

Engine rpm	Prop rpm	Thrust	Throttle position
55,000	1300	11N	0%
100,000	2820	25N	32%
120,000	3600	37N	46%
140,000	4230	57N	60%
160,000	5070	85N	75%
180,000	6240	128N	89%
195,000	7110	167N	100%

From the chart can be seen that the thrust roughly doubles from an engine speed of 160,000 to 195,000rpm (85N to 167N) which in throttle position terms is from 75% to 100%.

From this it can be seen that the 50% stick position is likely to only produce about ¼ of the thrust. This means in practice that most flying tends to happen in the 2nd half of the stick and therefore a lot of the useful resolution of the stick is not used for best effect.

Using this data it should be possible to input a suitable curve which allows for a better power spread across the range of the stick travel. Ideally the response curve should initially rise steeply and then flatten down towards the top end of the range.

After running

Always allow the engine to idle for about 30seconds after running before shutting off. This will allow temperatures to stabilise and oil flows to normalise after the flight. Pulling the trim to off will shut off the engine and start the cooling cycle. This will continue until the ECU registers a cool enough temperature and will then read "Stop".

As the temperature is measured in the heavy interstage casting there will be some heat creep after the engine has come to rest and the temp may creep back up to even 150-160'C, this is normal.

Waiting to fly again
If you have refuelled and want to make another flight and after you have turned the ecu back on there is still a temperature showing over the minimum start temp of 100'C. If you keep the trim set to off, you can blip the starter by raising the throttle stick briefly to apply a quick cool-down pulse which should bring the temperature down quickly. Don't hold the throttle stick at full for more than a second or so as this is also the signal for priming the pump which is not recommended at all as it can be the cause of flaming starts.

Once showing below about 98'C you can raise the trim and go for a start in the usual way.

Storage

The unit does not need any special attention after running although some thoughts on storage can be considered:

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 couple of 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 plane on the wall with its nose at the top as the oil can run out into the exhaust area and can cause a large cloud of smoke on the next start. If you absolutely have to hang the plane on a wall, keep it nose down. Horizontal storage is better if you have room.

Always empty the propane tank in the plane (if you have on-board propane) after you are finished for the day. Don't even wait to get home first as if the system springs a leak it might be in the car on the way home.

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.

Basic Servicing

Starter O-ring

There is little for you to do in the line of servicing so if the unit is working - leave it alone. After some time however the starter motor may start making screeching noises which indicates the rubber O-ring in the clutch is worn.

The starter motor is held on the engine with three small grub screws and after loosening these two turns the starter can be withdrawn.

The O-ring can then be seen and picked out with a pin. A new one can be ordered from Wren Turbines and popped in. The reverse procedure is used to replace the motor but the clutch operating length must be reset.

To set the operating length of the clutch, pull the black cap off the motor, loosen the grub screws slightly and gently push the motor all the way in. Then pull the motor back out about 1.5mm (1/16") and *gently* nip the grubscrews up. Do not tighten too much or the magnets will crack with a sickening crunch and it might mean a replacement starter.

A small drop of nail varnish on the screws will help ensure they don't vibrate loose. Don't use a strong locking compound or they will be impossible to remove later.

GlowPlug Replacement
It is presumed the operater is proficient at replacing the plug but a note on it's preparation may help. The plug must be replaced by one of the same type – the settings in the ECU on plug power rely on this. If you replace it with one with aheavier element the ECU will surely blow it on the first go as it will supply too high a voltage for it. If you go into the ECU settings and scroll through you will find a "GlowPlug Power setting". It is normally set to about 34. If your replacement plug is not the same as before reduce the value by 10 and try it. It is easy to raise the value by 3 or 4 at a time if it will not ignite.

A new plug will need its element teased out gently in order to expose the element to the propane for satisfactory ignition. It is easily broken if overdone and if not done enough will not work well. If you are not confident to do this you can order a pre-prepared glow plug from Wren Turbines.

The element should be teased until the coil is just nicely visible.

Place your thumb nail over the area where the element wire is welded to the body to help stop it from breaking as this is the usual point.

Many glow plug elements are broken by nervous trembling fingers bashing the element against the side of the plug-hole as it is being replaced into the engine. If you are not sure you can do this carefully get someone else to do it for you.