WREN 44 TURBOPROP

INSTALLATION AND OPERATING MANUAL

September 2008

WREN 44 TurboProp Manual

Congratulations on your purchase of the new miniature Wren 44 TurboProp gas turbine engine.

This manual has been prepared to help you set up and safely operate your engine. 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 near 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.

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Front Cover Pictures - Acknowledgments:

Front page upper – the first 44 Turbo-Prop prototype installed in a Pilatus "Porter" for gliding towing, by kind permission from Lucien Gerard, Luxemburg.
Front page middle - the 2nd prototype Wren 44 Turbo-Prop installed in a Top Flight "P51 Mustang", by kind permission from Lucien Gerard of Luxemburg.
Front page lower left – the first production Wren 44 Turbo-Prop installed in a Graupner "Taxi". By kind permission from owner, Barrie King.
Front Page, lower right – Wren 44 Turbo-Prop installed in a YAK88 from ExtremeFlightRC, flown by Jeannot Behm.

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The new Wren 44 TurboProp

Introduction

This new development from the highly popular Wren 44 Gold thrust engine stable, has been long awaited. It has built on the success of the Wren 54 Turboprop which has now been on sale in various forms since 2002. The engine has been 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 turbo-props. The engine is not modified for use in this application apart from a small hole drilled in the case to add a lubrication port, enabling the full perfomance to be used in driving the propeller, producing performance usually described as *"awesome"* by all those witnessing it.

The gearbox assembly is strongly built to withstand many hours of operation and is designed to be lubricated with a small fuel take-off from the engine. All this is automatic and the user need do no more than put fuel into the tank, charge batteries and go fly!

We have tried hard to produce a compact high power to weight engine capable of filling the gap left by the noisy medium to large I/C engine, and the existing range of turbo-prop engines now becoming available. Most of these are really only suited to large aircraft around 2.5 to 3m (8' to 10') wingspan, which has implications for cost, transport and suitability of flying field. There are a large number of airframes already available in the 2m (6') size that are attractive for conversion to turbo-prop for the reasons outlined above and are suited for the average club flier. The low installed weight around 2kg compares well with equivelent 2-cycle engines and helps to keep the wing loading sensible.

Noise is becoming a major concern and the 44 turbo-prop enjoys a remarkably low noise figure, rivalling electric models in many cases. The noise is predominantly propeller noise and with the smooth application of torque and total absence of power pulses enables a very low perceived noise level to be achieved.

The Wren 44 Turboprop 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 prop hanging and the usual aerobatics. The small engine size enables the fuel consumption to be described as "stingy" so no need for lugging a big fuel bottle around.

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 - Enjoy!

From all the team at Wren Turbines Ltd
February 2008

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 still flies in an Embrear Tucano and encouraged this development from the start.

Lucien supplied aircraft for flight testing the 1st and 2nd Wren 44 turbo-prop prototypes and undertook all the test flying. His generous help and feedback has greatly assisted and encouraged us to push this unique development forward into successful production.

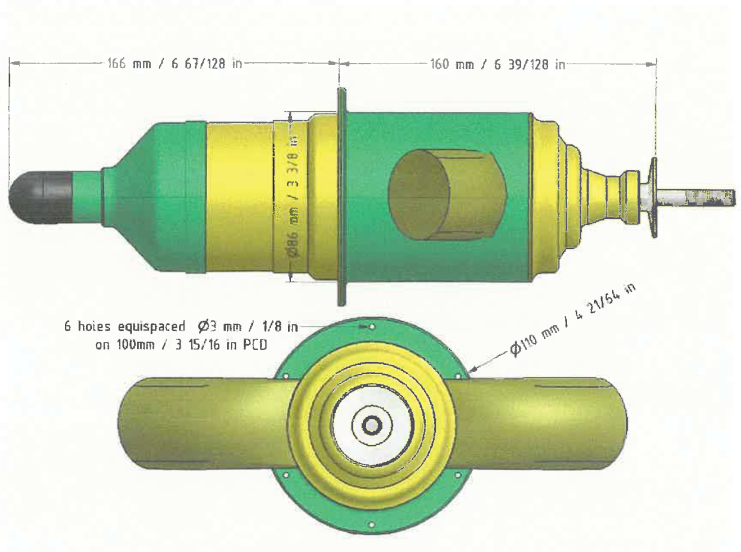
Thank-you.

The Wren 44 TurboProp package contains the following:

1) Wren 44 TurboProp Engine
2) Fuel pump
3) Autostart ECU (Engine Control Unit)
4) ECU data display terminal
5) ECU Battery (2-cell LiPo)
6) Propane canister valve
7) Fuel solenoid
8) Propane solenoid (with attached adjustable flow control valve)
9) Propane tank and one way valve
10) Felt clunk
11) Brass two-part quick-release propane connector

Lay out the engine and its support equipment on a clean surface and identify all the components.

Weights and Measures



Weights:

Power unit complete with cables	1710g	(3-3/4 lbs)
Fuel pump	88g	(3oz)
Valves (Propane and Fuel)	65g	(2-1/4oz)
ECU (Engine Control Unit)	35g	(1-1/4oz)
LiPo battery 7.4v, 1500mAh	80g	(2-3/4oz)
All up weight	1978g	(4lb 5-3/4oz)

Measurements:

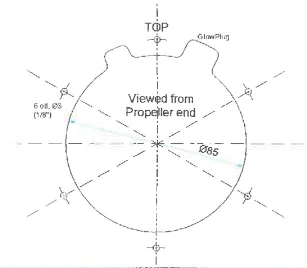
Overall engine length	365mm (14-3/8")
Overall width across standard exhausts	245mm (9-1/2")
Engine mounting flange to prop driver	160mm (6-5/16")
Mounting flange diameter	110mm (4-5/16")
Mounting bolt circle	100mm (3-15/16")

Mounting bolt M3 (or 4-40 UNC), 6-off, length to suit

Propshaft thread	M8 x 1mm pitch
Propshaft length	40mm (1-1/2")
Max propeller thickness	30mm (1-3/16")
Prop driver diameter	40mm (1-1/2")
Prop nut size	12mm A/F
Glowplug	JP PowerPlug type F

A couple of templates for making the cutout for the engine mounting are included at the rear of the manual, to full scale. Simply cut out, stick to the front of the firewall and cut through.

The template looks like this (reduced version for show only):



An determined look on the face of Lucien Gerard as he taxis out the 2nd prototype turboprop in the Top Flight "P51 Mustang" for handling checks, ouside Wren Turbines HQ. Nov 2007

General description of the Wren 44 two-shaft drive system

The Wren 44 TurboProp is the worlds smallest commercial 2-shaft turbo-prop engine. It is designed for use in miniature aircraft applications in place of an I/C engine. It is generally suited to aircraft up to 25kg (55lb) in all up weight and will replace I/C engines of around 80cc (4.8cu inch). The engine runs on standard kerosene and is supplied in full auto-start configuration.

What is a two-shaft system?
The two shaft system means there are two independant 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 and turbine attached at each end. This 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. It fulfills the function of what we call a *gas generator*. If a nozzle is attached to the outlet of the engine it imparts a slight squeezing of the gas into a high velocity jet for producing jet thrust and is 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 a 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 propeller. This 2nd turbine is much larger in diameter than the 1st stage and correspondingly runs much slower - up to *only* 90,000rpm - still far higher than any 2-stroke or electric motor could achieve, but at a high torque level. The energy given up by the gas driving the 2nd stage turbine drastically reduces the speed of the exhaust gas with the result than only a small residual thrust remains from the exhaust outlets.

What happens if I stall the propeller?
When operating from long grass or in a nose-over situation that causes the propeller to stall, the gas generator will continue to function normally with little ill-effects. On releasing the propeller 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 the long grass or nose-over situation - for you or your helper to keep well clear of the propeller whenever the gas generator is running.

What sort of gearbox is required?
The modest rpm levels generated by the 2nd stage turbine (by gas turbine standards) enable an suitable reduction to be contained in a small gearbox, the ratio of which is chosen to suit the operational needs of the load driven. In the case of the 44 TurboProp the reduction is 9:1 and this gives a propeller shaft speed range of 6,000-9,000rpm. 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 propeller is not at all critical, providing it presents enough load for the system (see warning below). The main criteria for propeller choice being the type of plane the unit is fitted to (scale, aerobatic, sports etc).

What are other two shaft examples?
Other Wren applications that use the same 2-shaft system are the Wren 44 Marine variant that has a 2.3:1 reduction gearbox for an output speed of 25,000-40,000rpm and the Wren 44 Heli unit with a reduction of 4:1 and output speed range of 12,000-20,000rpm.

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. This means the unit should never be run without a suitable propeller fitted.

What is the effect of airspeed on the engine?
Once the aircraft is in the air the propeller rpm will increase as its load reduces with forward speed. An rpm increase of 10-15% can be expected in the air so always choose a propellor that keeps the output speed below 9,000rpm. It is this increase in propeller rpm in the air which gives the turbo-prop 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-prop will enjoy running cooler as the propeller speed unloads leading to longer life and reduced loading on critical components.

How is it mounted?
The unit is housed within a purpose made containment system which encloses the hot section components in a three-section aluminium jacket enabling the installation to be limited to a simple firewall mounting and six bolts and nuts. This firewall provides the essential air separation for gas generator intake air and the warm air generated by the exhaust unit by placing a solid partition between them. In normal running the casing will only reach about 100-130'C minimising the chances of heat damage to the aircraft fuselage. No further stiffening is required or advised for the unit, this approach enabling the conversion from I/C engine to turbo-prop power to be accomplished with ease. The mounting supports the engine and gearbox at the approximate centre of gravity and is built to withstand all normal loads such as might be subjected to the equivalent I/C engine.

Aren't gas turbine more dangerous than I/C engines?
No. In the unfortunate event of a sudden arrival (or crash) the mounting helps to maintain containment of all the hot section parts from heat sensitive parts of the airframe and accessories. 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. With no exposed high temperature components the risk of accidental combustion is greatly reduced. As starting is undertaken with the operator and observers behind the propeller there is no possiblility of a sudden power surge allowing the aircraft and propeller to run forward to the operator such as can happen with I/C engines, with disastrous consequences for fingers and limbs. 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.

What's it like to operate?
The power unit itself is operated as a normal miniature gas turbine and possesses all the standard features of automatic push-button starting and cooling, totally vibration free operation, very quiet running and exceptional power to weight ratio. 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 it's 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. Those fliers used to a 3ltr fuel tank for equivelent flights should find this aspect of operation a welcome relief.

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 weighing in at only 1.71kg (3-3/4 lbs) 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 equipement. 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 aircraft with fully articulated surfaces, flaps and fine surface detail, can find themselves in. The high torque ability of the engine allows it to cope well with a wide range of prop sizes and shapes which will enable those scale three and four blade props to be a practical reality and further add scale effect. Almost all aircraft will enjoy an installed power to weight ratio exceeding 1:1 - in many cases

exceeding 2:1! With a static thrust exceeding 16kg (35lb) the unit should be quite adequate in power to enable an acceptable flight performance in a plane of 25kg (60lb) or more.

What about flying in noise sensitive areas?
Fliers with noise sensitive flying fields will enjoy the almost silent operation of the unit comparable to electric flying. Such users are encouraged to make good use of the current crop of quiet propellors and resist the temptation to zoom around the field like a pylon racer! Sports fliers can make full use of the highly tractable response and enjoy quelling the myth that turbo-props cannot prop-hang.

What about smoke?
The engine itself is a clean burning gas turbine that does not produce any 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. The minimal oil percentage used in the fuel helps to minimize pollution from unburnt fuel, although operation of the gas turbine does produce an very distinguishable smell which for many is the "*raison detre*" of this type of model flying.

What propellers do you recommend?
An important question. In all cases, we recommend only **wooden props** as in the even of a nose-over in a taildragger aircraft, the prop will break and not damage the engine. Similarly, in the event of an undercarriage failure where the u/c will not extend and a belly landing is required, a prop strike is inevitable and a strong carbon prop will not bend enough to protect the engine and can cause serious damage to the propshaft. Wooden props are available in sufficient styles and shapes to cover most needs although users should satisfy themselves in the case of three or more blade props, that the hub fixing is adequate enough for the power of this engine.

Detail description of the Wren 44 two-shaft drive system

Gas Generator

The gas generator used in the system is the well proven Wren 44 GOLD engine which has the standard Wren FOD guard fitted – this is no place for a tea strainer. A lubrication port in the outer casing has been added and this connects through a stainless tube to the gearbox. Other than the lube outlet there are no other changes to the engine and the full throughput has been utilised to generate shaft power.

This TurboProp engine has been fully run and tested

It is important to stress the unit has been fully tested with all the components supplied with it before it left the factory at Wren Turbines Ltd. There should be no need to make adjustments other than setting the radio to the ecu. Please refrain from jumping in and changing things just because you or a friend have another Wren 44. The settings match the components used and may not be the same as you are used to.

Hot Section

A specially designed and manufactured miniature interstage and guide vane assembly, cast from high temperature stainless steel is bolted to the engine.

A purpose made 66mm power turbine – not just taken from a thrust engine, is cast in Inconel 713c and is fitted and running on a fully hardened and ground shaft in a pair of preloaded high speed ceramic angular contact bearings. The shaft tunnel they run in is made from low expansion stainless steel.

These components define what is called the hot section. Nothing has been left to chance.

Gearbox

The front of the turbine shaft is contoured with a hardened and ground gear profile and supplies the shaft power into a specially design high speed planetary gearbox. This heavy duty assembly utilising fully ballraced support shafts and the planet carrier has been ground and bored as an assembly to retain great strength and accuracy.

The housings are anodised 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. To keep the flow to a low level the oil percentage is maintained at 5% to ensure satisfactory lubrication.

The lubrication reaches the gearbox by a small pipe in the gearbox front wall and is fed from a special fitting mounted on the engine. The gearbox is designed to retain much of the lubrication and only release what is surplus via the power turbine bearing.

The Mounting

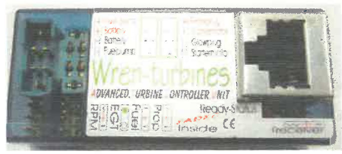
The gearbox housing incorporates a Wren Turbines' innovation – a fully integral mounting system. This specially designed housing answers two of the criticisms of turbo-props – that of their generally awkward mounting arrangement for gearbox and engine, and the amount of heat they generate within the airframe.

Our unique new system is machined from solid aircraft grade aluminium and carefully anodised to retain its corrosion resistant qualities and durability of finish. It provides a secure and rigid connection between the firewall and gearbox and provides full support to the gas generator at its C of G. This eliminates the danger of distorting the hot section between the engine and gearbox when individually clamping engine and gearbox to different sections of the airframe. The Wren system also allows a very simple mounting for the engine – just align the supplied template (at the back of this manual), and cut out the shape, drill the six mount holes and bolt onto a firewall like a 2-cycle engine. This also allows for the simple offsetting of the thrust line by simply building it into the firewall at the point of construction, as recommended or included for the I/C installation.

The mounting has a further advantage – it envelopes the hot section and exhaust sections and holds in the heat which would normally be released to the interior of the aircraft. Such heat release can cause heat damage to paint finishes cowl materials, or make it difficult for the engine to get an adequate supply of essential cool air for the engine to run on. We think the system is so good that some day all turbo-props will look like this.

Ancillaries

ECU (Engine Control Unit)
Data display terminal
RPM pickup (mounted in engine)
Temperature Probe (mounted on engine)
Fuel pump
Propane valve and flow restrictor
Fuel valve
Ecu battery
Propane tank



ECU (Engine Control Unit)

The ECU and ancillaries are identical to the thrust engine variant and use similar programmed settings. It is important however, that users do not change settings from those set without refering back to Wren Turbines.

The ECU is the well proven Digitech 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 Data terminal (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. 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 telephone style socket 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.

RPM Pickup
Mounted on the front of the engine, under the 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.

The pickup is sensitive to stray magnetic and electrical noise so be careful about routing cables close to it. The starter and glow plug cables are tightly twisted to reduce their stray signal for this reason – do not untwist them.

Temperature probe. The temperature probe is a standard miniature industrial thermocouple which is positioned in the interstage casting via the engine bulkead and 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 secured on the front of the engine and connects to the ECU via a small servo-type plug with a special green cable. It is attached to the engine and should not be moved from this position.

Fuel Pump. The fuel pump is one of two special gear type pumps especially made for the Wren 44 and turbo-prop. They have very small gears to allow a wide range of control for the engine and **must not** 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.

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 spoil the operation of this pump so only allow clean **fully filtered** fuel into it. Connect to a fuel tank by a single direct pipe with no connectors, fuelling valves, stoppers etc between it and the fuel pickup. The pickup should be a quality felt type clunk or propietry 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.

Propane Valve
This valve is a specially made brass body valve used to switch the propane gas on and off during the start phase. It has an "in" and "out" (marked by an arrow). The valve is powered by the propane outlet on the ECU and care should be taken to ensure it is plugged into the correct ECU socket. The valve coil is rated at 5v and may be tested with a 5v supply where a solid click can be heard. If it malfunctions the valve is not user serviceable and must be replaced. It is identical to the fuel valve in construction. Note – the "F" on the side of the valve base indicates the direction of "Flow" and not "Fuel".

Flow Restrictor
The "out" side of the propane valve has a short length of green tube attached by a quick release connector to a small adjustable "Festo"- type flow valve. This valve controls the volume of propane flowing to the engine for starting. It has been preset to the setting required for starting as part of the engine test so should be approximately in the right place already. There is a locknut just below the small blue control knob to help prevent it coming undone and should be loosened before making adjustments. Do not adjust the valve until you have tested it on an engine start and found you need to change the setting. It has a soft seat and fine thread so it is not easy to tell if it it fully closed or not.

To confirm operation, unplug the outlet to the engine and connect a short length of 3mm tube to the valve outlet. Fill your propane tank or connect up your usual supply, go for a start and after a click there should be a hiss of flow coming out of the valve. If not open the valve gradually until it does. Note the ecu will only allow about five attempts at a start on a single attempt before it shows "TimeOut". If this happens simply put the trim to off, then raise again to on and try again.

Fuel Valve
This is the same construction as the Propane valve with the same direction arrow. Test by simply blowing through while plugging it into a spare servo outlet on your receiver. There should be a click on powering. Again if it fails there is little to be done but replace it. The quick release connectors can be removed for re-use first though.

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

LiPo's must be charged with a charger especially made for this type of cell and we recommend those equipped with a balancer, or which charge through a balancer. The battery has a balancing lead and it is best if you charge through this.

Warning. It is very important you disconnect the battery from the ecu while charging or permanenet damage to the ecu can result. Such damage is checkable and ecu's so damaged will not be replaced under warranty. It is good practice anyway to remove the battery from the plane and charge in a safe area.

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 drain a LiPo down to nothing in a couple of weeks. In this case the battery is deep discharged and permanently damaged – ie scrap. A LiPo so discharged will not be covered by the warranty.

Propane Tank
This small tank is supplied for customers who wish to have an on-board propane system. It is intended for mounting upright in the plane and to hold enough for four or five starts. It is intended to be only filled to about 1/3[rd] to ½ full maximum. The connector on top enables the feed supply from the outside to enter the tank and the outlet supply to exit the tank to the propane valve separately. The advantage of this system is if it is a very cold day you can simply leave your external propane supply plugged into the tank but not supplying liquid, and make your start as normal, making use of the larger capacity of the external supply.

It is good practice to vent the propane tank at the end of the flying session to ensure no propane is left in the system that if seeped out could present a fire hazard.

Off-Board Propane
Many fliers prefer to have off-board propane supply and in this case, simply pipe the quick release fitting directly to the propane valve. The quick release connector and pipework is supplied to enable either arrangement to be achieved.

Canister valve
A canister valve is also supplied to screw onto your propane canister. Traditionally this has only fitted canisters available in Europe but these are now becoming common in the USA. This simple valve operates by pressing the small sealing ball off its seat in the neck of the canister. Control is attained by how far the ball is moved. The control works as a normal tap, ie to turn on the propane turn the screw cap anticlockwise in the "+" direction, to turn off rotate clockwise in the "-" direction. It is not necessary or desirable to move the cap more than about three or four turns as the cap can be undone totally until it falls out – potentially allowing a propane escape.

Warning
Whatever system you adopt it is very important not to allow liquid propane to reach the engine. This can cause flaming and aggressive starting and can damage the engine.

Secondly
It is most important to remember that propane is highly flammable at all normal temperatures. Please be very careful during filling or purging to keep everything away from sources of ignition.

Thirdly
Also remember that at high ambient temperatures pure propane can attain very high pressures that can cause pipes to blow off their connectors. If it is deemed there is any possibility of this happening or if you experience this, then switch to external plug-in propane which reduces significantly the possibility of large propane release inside the aircraft.

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 the manufacturers 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 engine test stand or model installation. The thrust is very considerable for such a small size and mountings must be sufficient to withstand such forces. Use appropriate screws and proper captive nuts. 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 CO_2 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.

The starting gas (propane) is highly flammable and must be used with extreme care. Maintain canister and fittings in good leak-proof condition. Protect from sunlight and prevent exposure to temperatures exceeding 50'C. Keep out of reach of children. Discard used canisters in a safe place and do not puncture or incinerate, even when empty. Avoid deliberate inhalation.

Ensure gaseous propane only is supplied to the engine, liquid gas must not be allowed to pass into the system. Gas supply must be disconnected until ready for immediate use. Gas is heavier than air and can fill a model if allowed to leak unchecked, and become a potential explosion hazard.

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 glow-plug to test it, keep fingers or bare skin away from possible burn from the glowing element – 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 engine whilst it is operating. The safest position to operate the engine is in the area behind the propeller. The area sideways on to the engine is potentially the most dangerous area due to the rotating propeller. You and people around you must keep well clear of this to a safe distance. In certain light a turning propeller can become invisible – add some colour to the propeller tips if you notice this with yours. If operating from a pit area take special care as safety distances are often difficult to maintain and passers by can appear without warning.

Keep all helpers close by and brief them fully on their duties before starting the engine. One helper should carry out the role of fireman. Ensure they are aware of what to do in event of emergency and where to position the extinguisher if required.

Never attempt to alter the starting characteristics of the engine by spraying ignition agents into the intake, as might be 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.

The warranty

Wren Turbines warranties this Wren44 TurboProp engine and associated equipment, free of mechanical defects in workmanship or materials for two years after purchase date.

Engine Control Unit (ECU).
The ECU has a one year warranty which covers repair or replacement of the main unit and the display. Improper use such as polarity reversal, short circuit, ingress of foreign matter or crash damage is excluded.

Warranty Conditions:

1 The engine may not be dismantled except the removal of the front (green) cover, to access the service connections and speed sensor.
2 The fuel pump, ecu and rpm pickup may not be dismantled or manufacturers seal/covering broken by way of investigation. If either unit is suspected as defective it should be returned intact to Wren Turbines Ltd who will check the serviceability of the item and replace if found defective.
3 The engine MUST be started and operated exactly as instructed. This includes (i) correct mounting of the engine with correct inlet and exhaust ventilation (ii) use of the correct battery packs (iii) use of the supplied fuel pump (iv) use and correct operation of the supplied ECU, (v) use of supplied wiring harness.
4 Only the recommended fuel is used.
5 Excludes parts damaged by excessive heat due to incorrect operation (starting, running, cooling etc).
6 Excludes parts damaged by ingestion of foreign objects (ie wires, model materials and fittings, water, sand or grit).
7 Excludes engine repairs where blockages in the fuel system have occurred due to use with unfiltered, or contaminated fuel.
8 Excludes damage to the unit in event of nose-over or damage inflicted through prop-strike.
9 Crash damage to the engine and its ancillaries is not covered by the warranty.
10 Warranty is not transferable.

Notes for the inquisitive.
Please do not attempt to disassemble this engine. You will breach your warranty agreement and you will find it is a precision assembly which you will be unlikely to re-assemble without considerable difficulty and specialist equipment. Simply slackening the spinner nut of the rengine otor may lose the delicate balance condition without which the engine may not run without damage to its rotating assembly.

You are permitted to access the fuel and gas connections under the green cover in event of repair or replacement of the fuel or gas pipes. Access may also be gained to the magnetic rpm pickup if repair or replacement is required. Access to the gearbox should never be required. It does not require cleaning out or additional lubrication so should be left alone.

You may not dismantle the engine further. Any further investigation must only be undertaken by Wren Turbines Ltd.

Repair.

Damage or defective operation covered under the warranty terms will be repaired and tested at no cost to the original owner (other than post and packing). Repairs not covered under the terms of the warranty will be carried out by Wren Turbines Ltd, or their appointed agents, after agreement of costs.

Before returning the engine or ancillary equipment for service or repair, please contact Wren Turbines Ltd or Wren Service Agent to agree action and costs. When returning an engine please be sure to seal both gas and fuel pipes and pack the pump and engine unit in clean polythene bags to prevent entry of dirt.

Performance

We have tested the turboprop unit in a variety of situations and loads. The main indicator of the performance of the unit from the users point of view, is the rpm that can be achieved with a given propeller load. Larger propellers and/or more blades produce higher torque figures but not always the highest thrust figures.

We have listed the outputs for a range of propellers and the thrust produced for each combination together with the calculated torque and shaft power figures. From these it should be possible for the reader to gauge the ideal propeller combination for their aircraft.

The figures are reproduced in order of highest thrust first and are with gas generator at maximum speed - 195,000rpm.

Propeller	Size	RPM	Static Thrust	Torque	KW	HP
2-Bladed:						
MENZ-S	610 x 200 (24" x 8")	7110	167N	6.82Nm	5.08	6.81
MENZ-S	610 x 305 (24" x 12")	5900	160N	7.06Nm	4.36	5.84
APC-N	430 x 305 (17" x 12")	8900	95N	4.49Nm	4.18	5.60
3-Bladed:						
Mejzlik	560 x 305 (22" x 12")	6300	150N	8.52Nm	5.62	7.53
Mejzlik	510 x 305 (20" x 12")	7020	135N	7.22Nm	5.31	7.12
MENZ-S	460 x 305 (18" x 12")	7540	128N	5.47Nm	4.32	5.79

Note the high rpms achieved with the smaller propellers. It is most important that propellers smaller than listed are not used or if they are the maximum rpm should be reduced on the engine, to prevent the possibility of overstressing (the propeller). In all cases, follow the propeller manufacturers recommendations for preparation and use.

NOTE
The maximum speed of the unit with ***any*** propeller should not exceed 9,000rpm on the ground.

Propeller Selection and Balancing

Some examples may help to answer questions about choice of propeller:

1) Slow flying "glider-tug" 2.5m span. Ideal propeller is a large diameter around 560-610 (22"-24") and shallow pitch around 200 – 250 (8"-10"). If there is a problem with ground clearance with the larger diameter, then a 3-bladed one can be selected. In this case a diameter of around 50mm (2") smaller in diameter - 510 (20") would be suitable, with a 250 or 200 (10" or 8") pitch.

2) Fast flying sports type "Extra" or similar 2.20-2.5m span. Ideal propeller is 560 x 305 (22" x 12") 2-blade or 510 x 305 (20" x 12") 3-bladed. The larger pitch and smaller rpm allows a higher propeller rpm and corresponding high forward airspeed.

3) Reasonably fast scale type "Tucano" or similar, 2-2.5m span scale type. Ideal size is 560 x 305 (22" x 12") 3-bladed. The larger diameter and pitch enables plenty of thrust for good forward speed with a quiet operation and scale appearance.

It is worth noting that the thrust measures are *static* figures, the dynamic thrust (when the aircraft is in flight) will reduce as aircraft airspeed increases and is a function of all propeller driven aircraft. However, it is worth reminding that the thrust on a turbo-prop falls off more gradually than an I/C engine due to the fact that as the propeller load reduces due to forward speed ("unloading") it's rpm rises to balance the torque supplied. This feature enables turbo-prop powered aircraft to achieve a higher forward speed than the static rpm suggests, or the same speed achieved for a reduced throttle setting.

Ultimate forward speed, it should be reminded is mainly a function of forward thrust against airframe drag. A slippery airframe will result in far greater performance on even modest power levels, whereas a large draggy airframe may fly slowly on even exceptional power.

Propeller Balancing

It is imperative that propellers used on the turbo-prop are balanced to a fine degree as the engine is produced utilising a high standard of balance on assembly. A standard propeller, new and just out of the box is very likely to be significantly out of balance and using it in this condition can cause damage to the engine through excessive and rapid wear on bearing journals and potential fatigue failures of the fuel system in the engine. Such imbalance can be easily seen when an engine is running by the tail fin or tail surfaces trembling.

Balancing is equally important if you plan to install a spinner, particularly if it is one that has an aluminium backplate. Such spinners can have a similar severe effect on the smoothness of the unit and must receive similar care to the propeller.

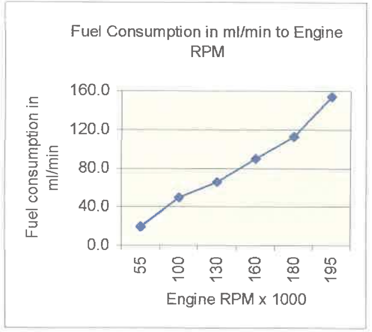
Simple and highly effective propeller balancing units based on a pair of magnets have been available commercially for many years (see the "Top Flight" one at left), or alternatively those with facilities can produce their own. Imbalance correction is normally a combination of scraping the heavy blade evenly towards the end of the blade – never at the root as this can weaken it. Alternatively, light sprays of clear fuel proofer on the light blade will achieve the same result.

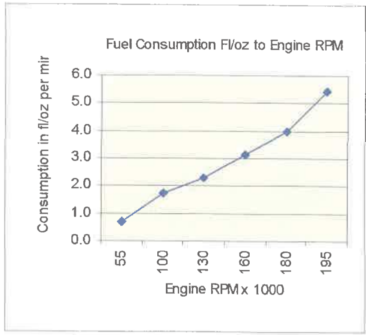
Important - No attempt should be made to add material, lead shot or coloured sticky tape to the light blade as this is sure to fly off later and if you are lucky it might not to hurt someone, but the resulting out-of-balance running could cause major engine damage. If this happened in the air you would not know until it was too late. The warranty will not cover you for such damage.

Fuel Consumption and Flight Time Endurance

Fuel Consumption

Fuel consumption means the quantity of fuel required to achieve the specific power level indicated. For fliers, it is not such a useful figure as it is a single setting quantity and doesn't represent actual flying. The full power figure is useful as an indicator of the worst case maximum consumption figure and the likely minimum flight time achievable. Endurance basically means how long a plane can fly under power for a given quantity of fuel, including take-off and landings – there must be at least one of each of these for every flight!





The fuel consumption of the turbo-prop unit is proportional to the power used and for most fliers this will vary considerably depending on the type of aircraft and duty undertaken. A slow flying glider tug might use full power for one minute and then reduce to quarter power to circle for several minutes and land. A fast sports type aircraft might use full power extensively during its flight including prop hanging and full power ascents. A scale type model might use full power for just a few seconds for take-off and never use full power again in the flight.

So fuel consumption figures must be used sensibly with an eye on how the engine is operated.

Fuel tank capacity

The duty cycle anticipated of the aircraft will impact the choice of fuel tank capacity. There is little point carrying around 3ltrs of fuel if the flying requires only 0.4 ltrs per flight. Equally there is no point having a 0.5ltr tank for a fast aerobatic aircraft that is required to perform an eight minute show slot (it won't!).

In general we recommend a compromise tank size for most aircraft of 1.5ltrs (50oz) which should allow plenty of flight time (8mins+) and assures a reliable supply of fuel and a decent reserve to keep the system filled.

It is not good practice to choose too small a tank as you run a greater risk running the tank dry which will allow air to enter the fuel system. This can be difficult to remove afterwards and can make the system unreliable if air bubbles remain. If you plan a lot of high power manouvers and/extra long flights then a 2ltr tank may be a better option. It is sensible to allow for about 25% extra capacity from your requirement to ensure consistent fuel supply.