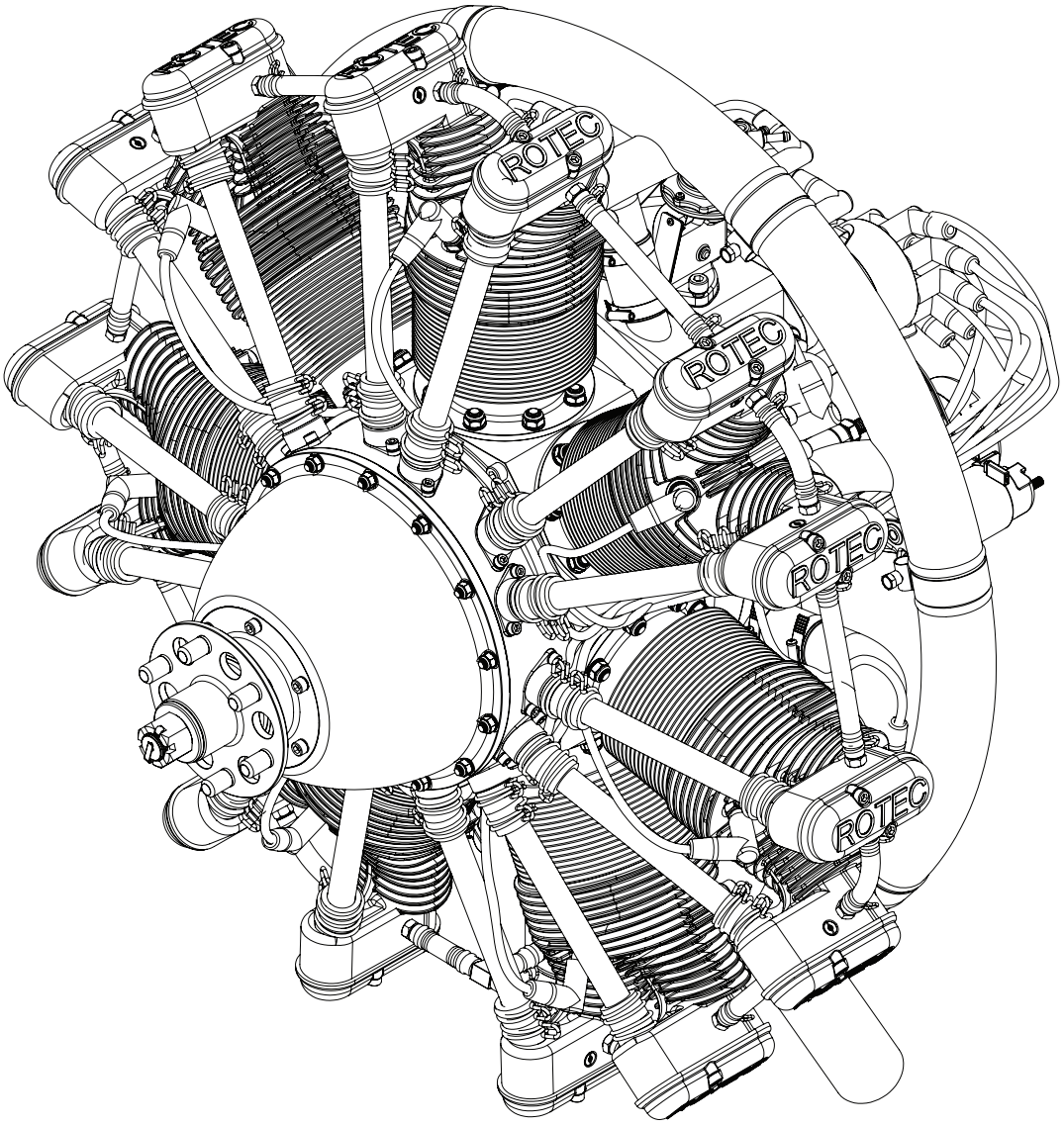
ROTEC

AEROSPORT

RADIAL ENGINE OPERATIONS MANUAL



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INTRODUCTION

GENERAL NOTE

This technical document is a guide to aid the user to correctly maintain, service and operate a Rotec Radial aircraft engine. This operations manual was completed for your benefit.

Congratulations on the purchase of your band new Rotec Radial engine. Rotec's radials are constructed with the highest level of precision & accuracy. Each component has been rigorously tested by technicians to ensure quality, endurance and performance of your radial engine.

The contents of this manual are based on the latest product information available at the time of publication.

Should you have any doubts or question in relation to the contents of this manual please contact Rotec Aerosport Australia Pty Ltd.

WARNING

GENERAL WARNING

NOTE, IMPORTANT & WARNING boxes are used through out this manual. This is to disclose safety issues that must be followed when operating Rotec radial engines.

NOTE:

IMPORTANT:

WARNING

Always provide a copy of this manual to anyone using this equipment. Read all instructions in this manual and any instructions supplied by manufacturers of supporting equipment before operating the radial engine and especially point out the “Safety Warnings” to prevent the possibility of personal injury to the operator.

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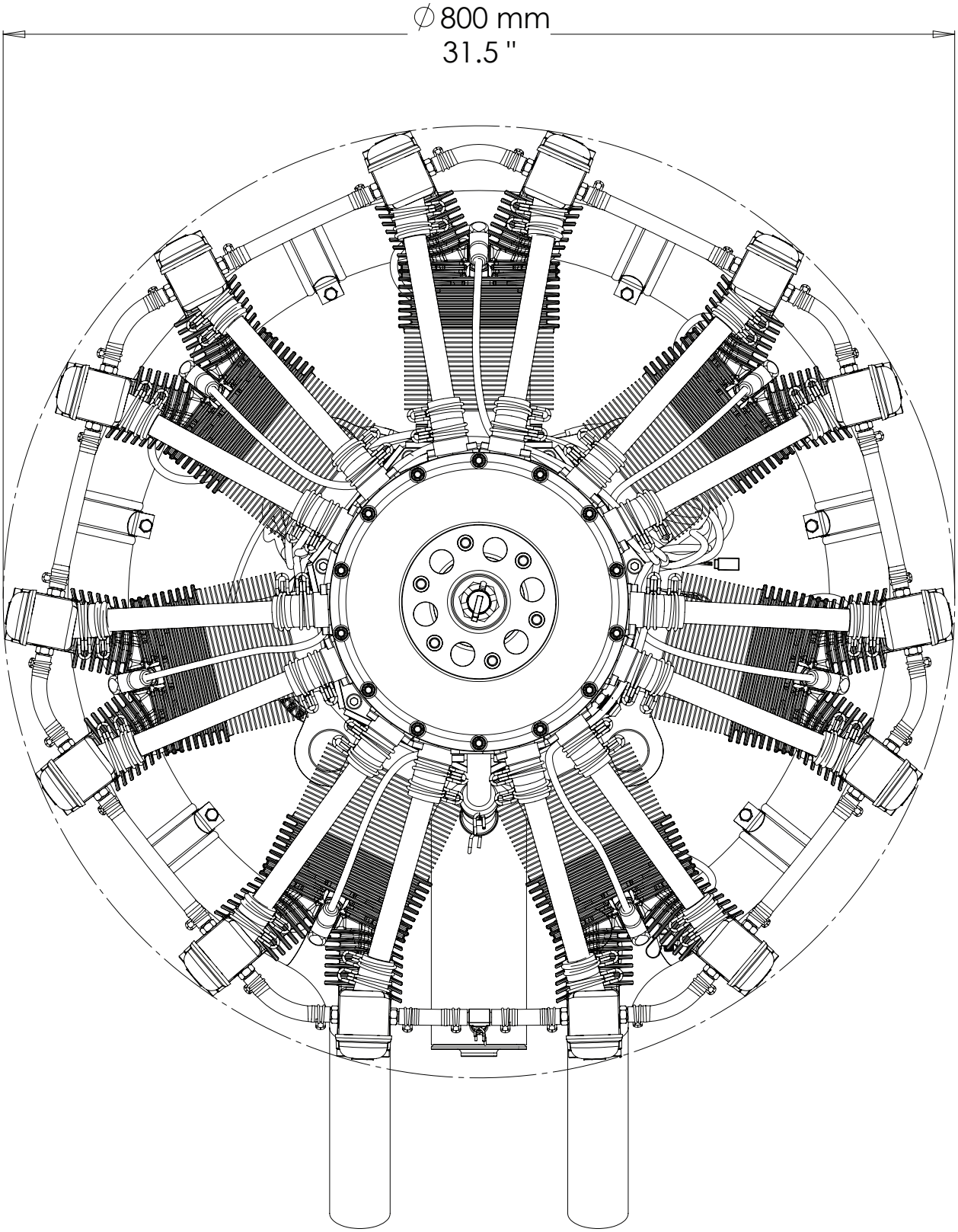


Figure 1. R2800 Front View

DIMENSIONED SIDE VIEW

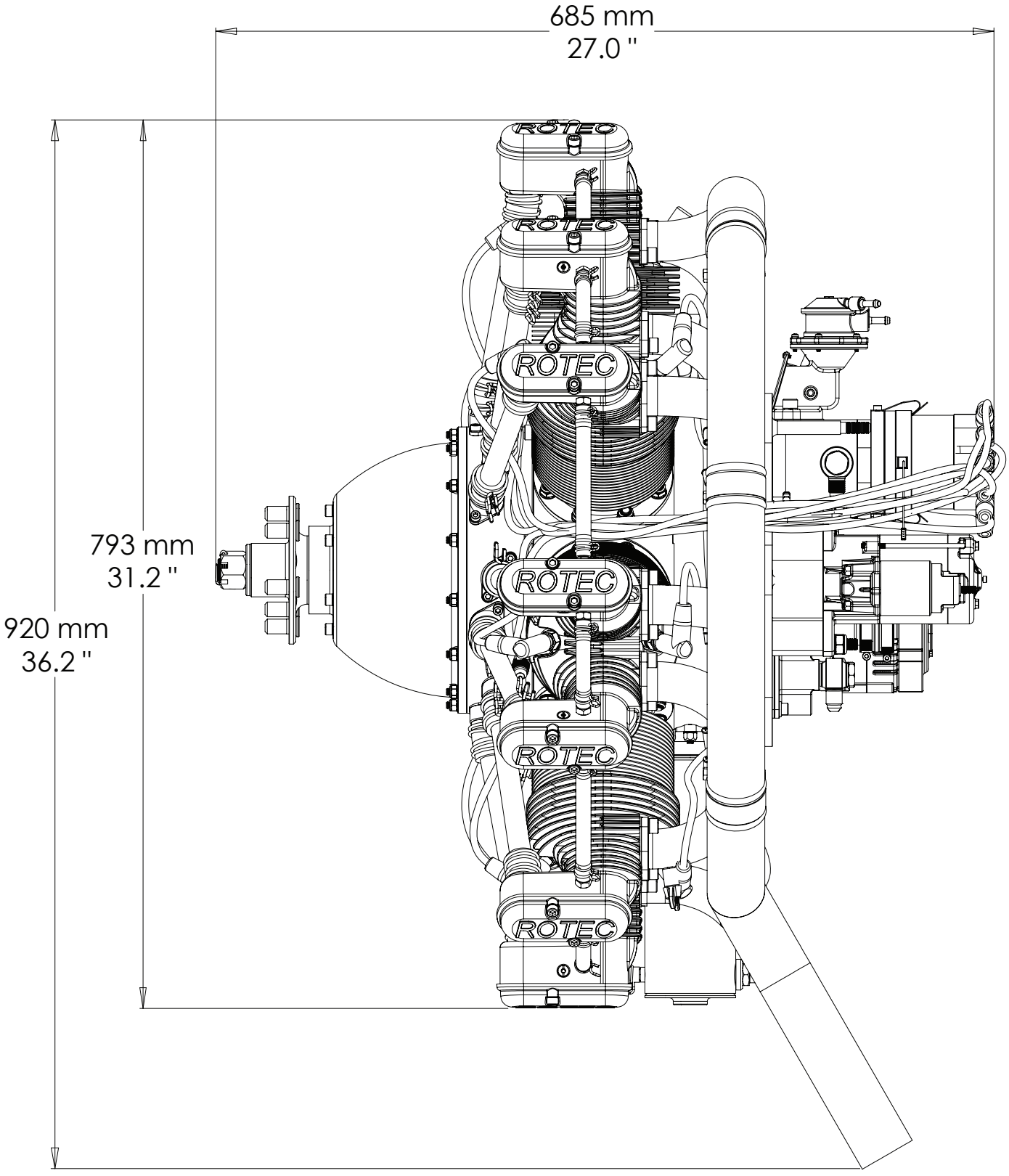


Figure 2. R2800 Side View

RADIAL ENGINE DESCRIPTION

REAR VIEW CYLINDER DENOMINATION

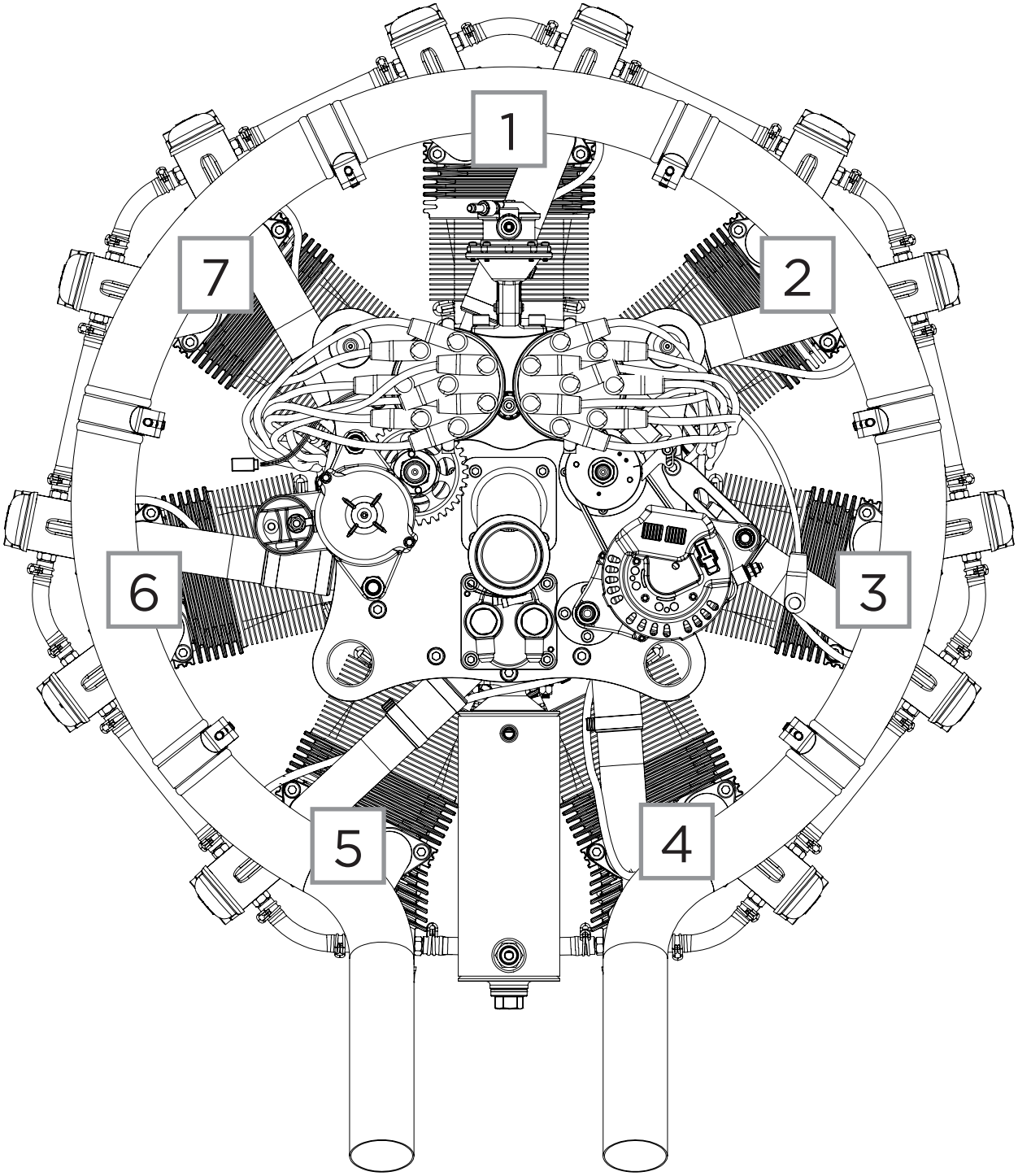


Figure 3. R2800 Cylinder Denomination

R2800 TECHNICAL DATA

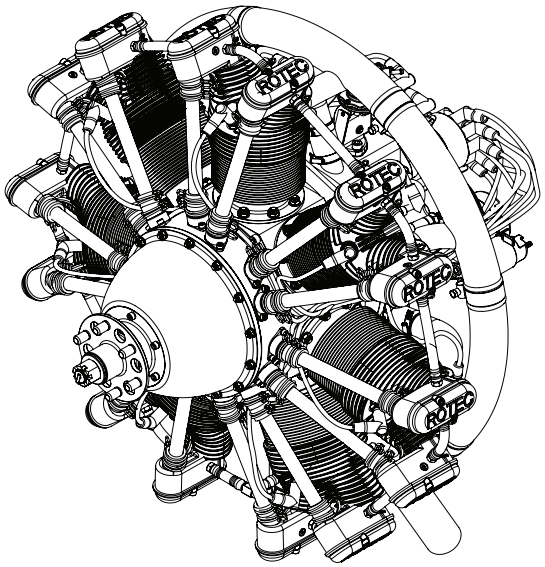


Figure 4. R2800 ISO View

ENGINE DESCRIPTION

Designers:	Matthew & Paul Chernikeef
Configuration:	7 Cylinder Radial Engine - Four Stroke
Ignition Systems:	Duel, Rotec Electronic & Magneto
Firing Order:	1-3-5-7-2-4-6
Carburettor:	TBI-Mk.II-40-S / Bing mixture control

DIMENSIONS & WEIGHT

Bore:	80mm (3.15'')
Stroke:	80mm (3.15'')
Displacement:	2800cc (172 cu'')
Compression Ratio:	8.5 : 1
Direction of Prop Rotation:	Clockwise Pilot's View, tractor
Engine Dry Weight:	110kg (220lb) inc. Starter, Alternator & Exhaust (Stubs)

PERFORMANCE DATA

Rated Power	110hp @ 2450 Prop RPM (via 3:2 PSRU)
Take Off / Maximum Continuous RPM	110hp @ 3700 RPM
Propeller / RPM	Fixed 76'' Diameter x 55'' Pitch @ 2,450 RPM

FUEL CONSUMPTION

Fuel Consumption @ 75% Power (cruise)	AVGAS 100 LL 22 Litres / hr (5.8 gallons)

RADIAL ENGINE DESCRIPTION

R3600 (9 CYLINDER ENGINE)

DIMENSIONED FRONT VIEW

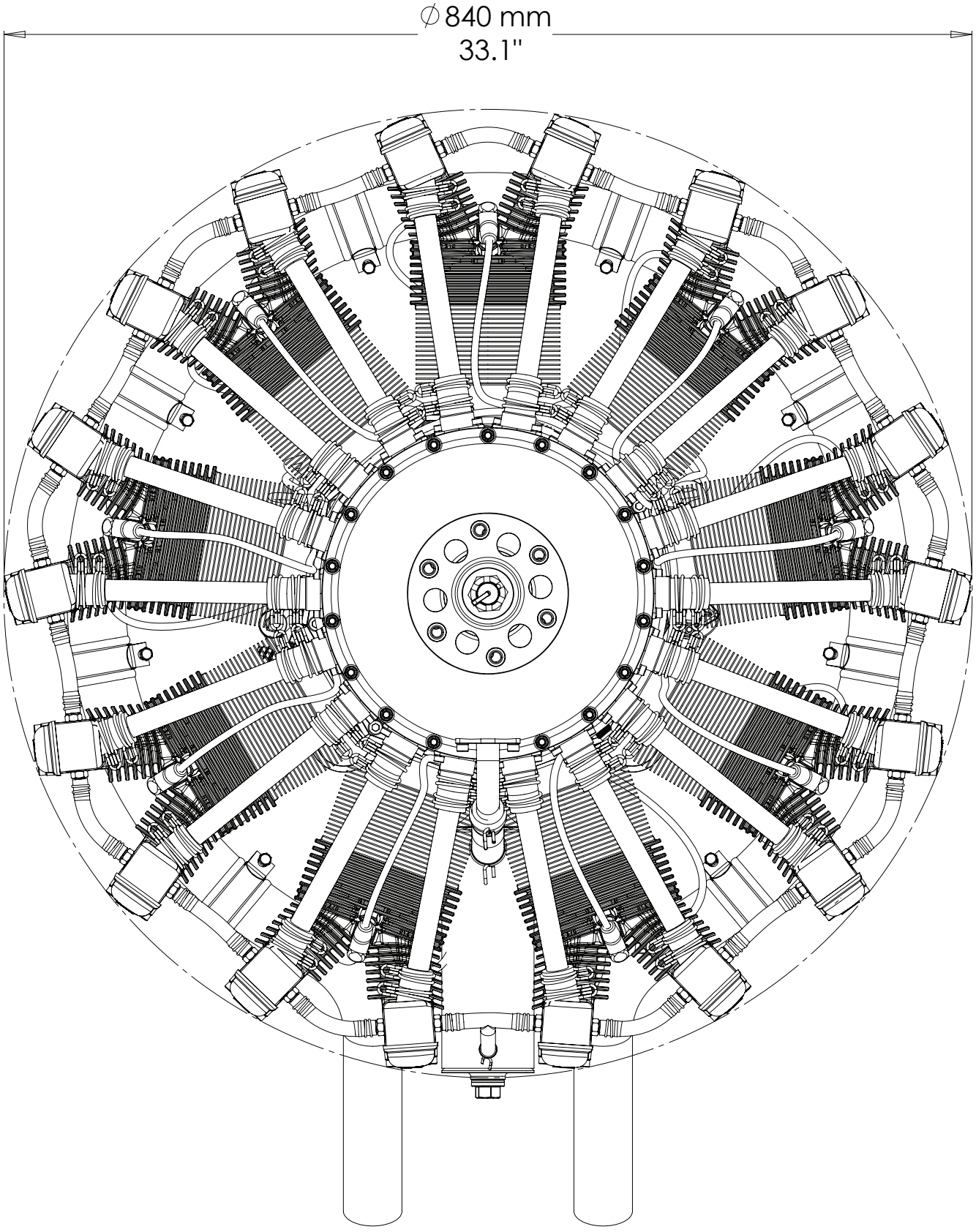


Figure 5. R3600 Front View

DIMENSIONED SIDE VIEW

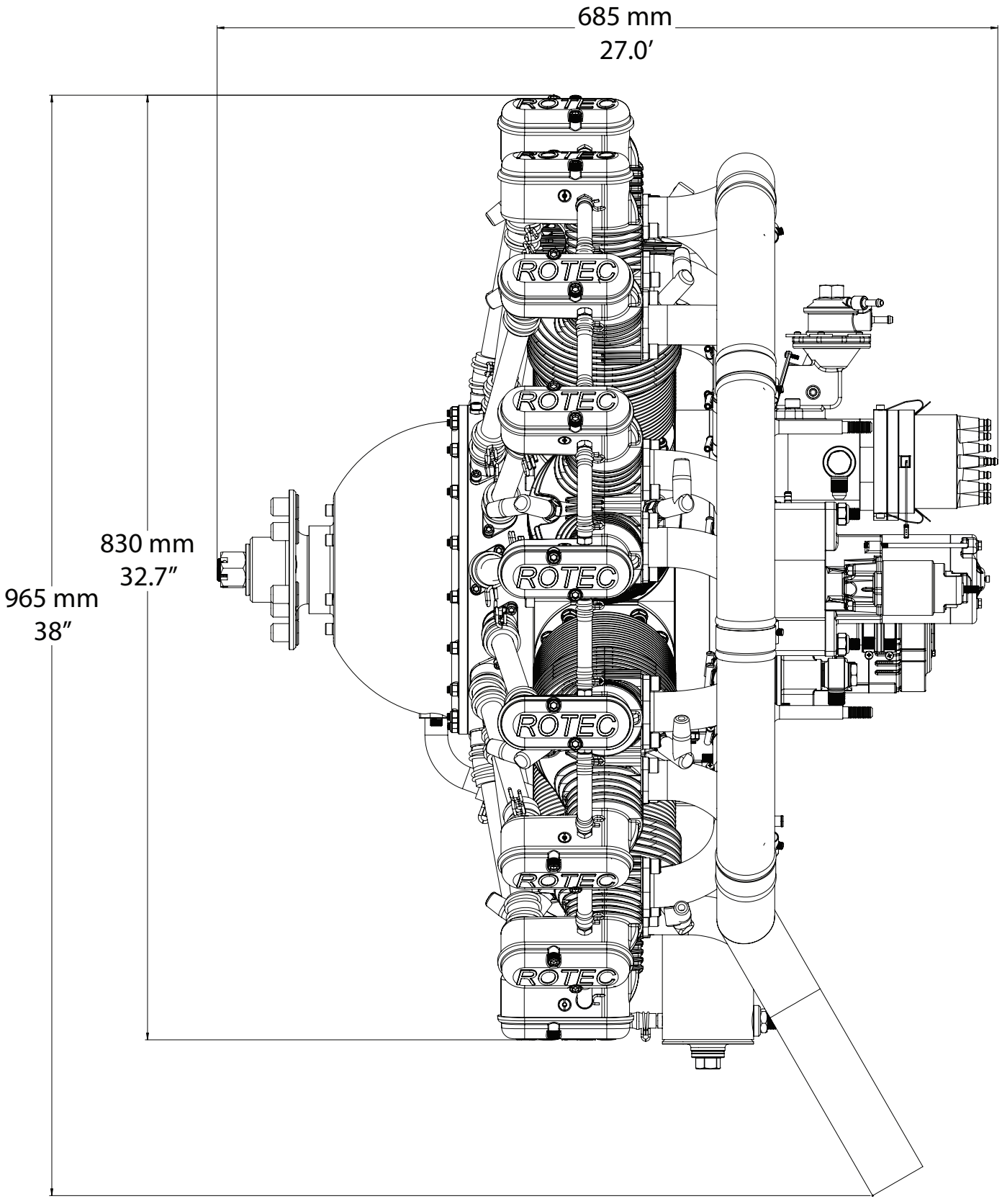


Figure 6. R3600 Side View

RADIAL ENGINE DESCRIPTION

REAR VIEW CYLINDER DENOMINATION

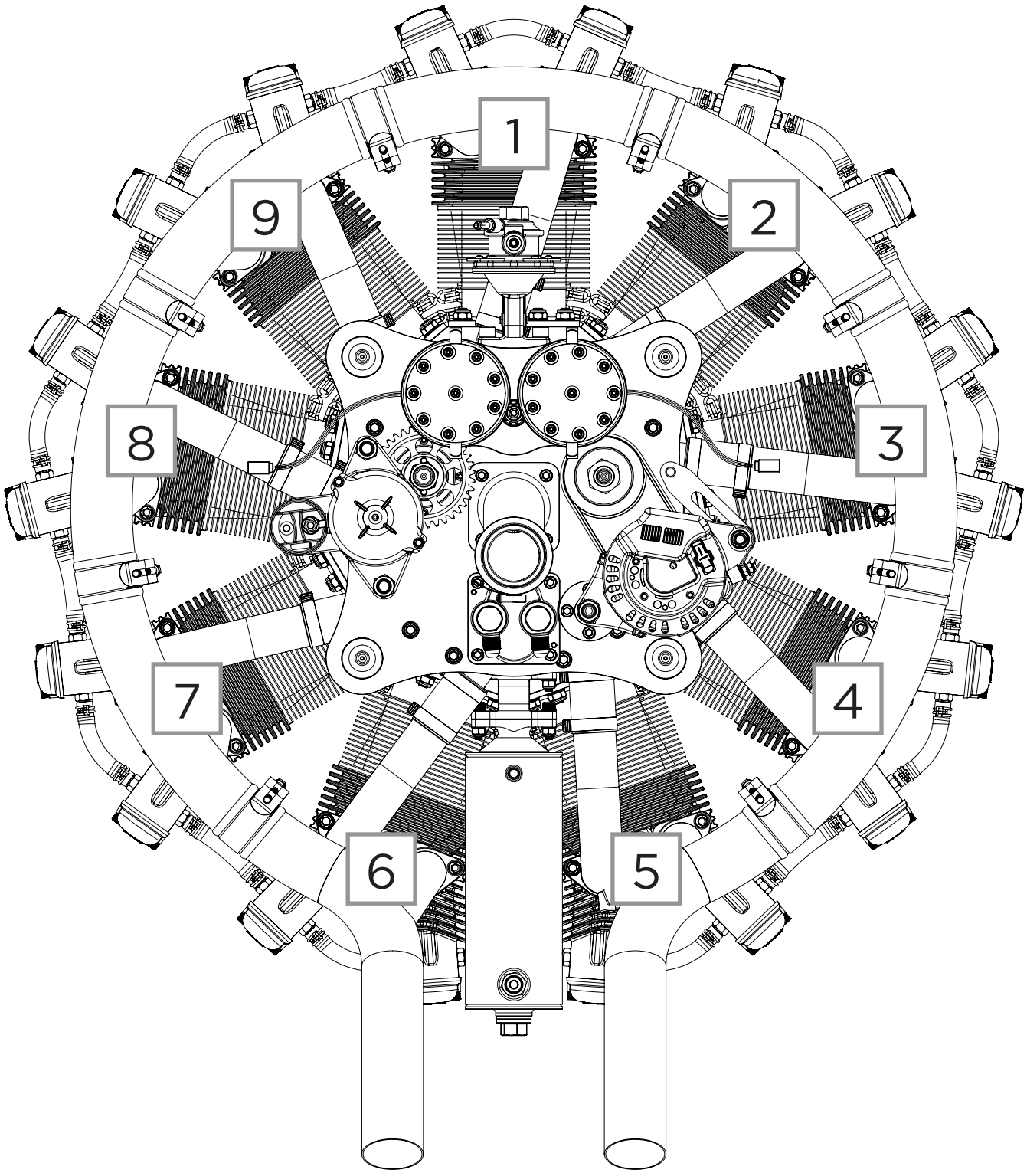


Figure 7. R3600 Cylinder Denomination

R3600 TECHNICAL DATA

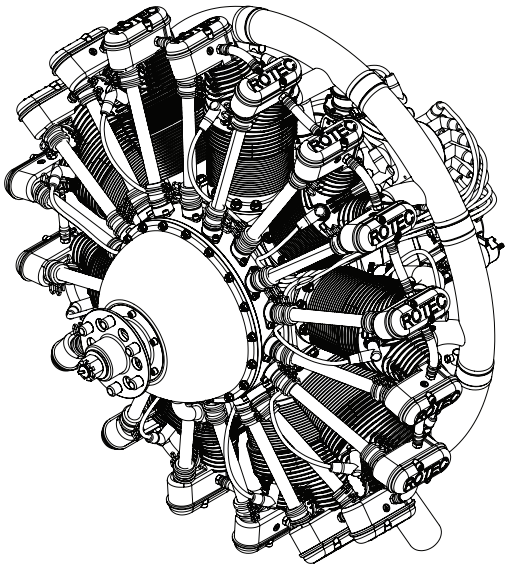


Figure 8. R3600 ISO View

ENGINE DESCRIPTION

Designers:	Matthew & Paul Chernikeef
Configuration:	9 Cylinder Radial Engine - Four Stroke
Ignition Systems:	Rotec Electronic
Firing Order:	1-3-5-7-9-2-4-6-8
Carburettors:	TBI-Mk.II-40-S / Bing mixture control

DIMENSIONS & WEIGHT

Bore:	80mm (3.15")
Stroke:	80mm (3.15")
Displacement:	3600cc (220 ci")
Compression Ratio:	8.5 : 1
Direction of Prop Rotation:	Clockwise Pilot's View, tractor
Engine Dry Weight:	120kg (265lb) inc. Starter, Alternator & Exhaust (Stubs)

PERFORMANCE DATA

Rated Power	150hp @ 2450 Prop RPM (via 3:2 PSRU)
Take Off / Maximum Continuous RPM	150hp @ 3700 RPM
Propeller / RPM	Fixed 80" Diameter x 55" Pitch @ 2,450 RPM

FUEL CONSUMPTION

Fuel Consumption @ 75% Power (cruise)	AVGAS 100 LL 28 Litres / hr (7.4 gallons)

UNIVERSAL ENGINE DATA

NORMAL DATA

System:	Description
Ignition Timing:	22 Deg. BTDC
Spark Plugs:	NGK DCPR8E
Electrode Gap:	0.55 - 0.60mm (0.22'' - 0.024'')
Charge System:	35 Amp 12 Volt DC Alternator
Fuel Filtration:	0.1 mm Maximum Particle Size
Fuel Pump:	Mechanical Cam Driven
Starter Motor:	Electric 12V / 1.0kW
Lubrication:	Geared Oil Pressure & Scavenge Pump
Bore / Stroke:	(3.15'') 80 mm x 80 mm
Heads:	Two Overhead Valves, Push Rod Operated
Spark Plugs:	Two Per Head (NGK DCPR8E)

FUEL TYPE

Fuel	Description
AVGAS 100 LL	Recommended
Highest Octane Premium Unleaded Automotive Petrol	Alternate*
NOTE: * When using unleaded fuel, carburettor & ignition timing adjustment may be required to avoid detonation.	

OPERATING RPM'S & LIMITS

Max RPM:	3700 RPM
Continuous RPM:	3500 RPM
Idle RPM:	900 RPM

Oil Pressure Cruise:	Min. 220 kPa (31 psi)
	Max. 520 kPa (72 psi)
Oil Pressure Idle:	Min. 80 kPa (11 psi)
Oil Pressure Warm Up:	Max. 520 kPa (72 psi)
Oil Temperature:	Min 15 C (59 F)
	Max. 120 C (250 F)
Continuous Oil Temperature:	50 - 110 C (176 - 225 F)
Max Head Temperature (Climb)*	220 C (420 F)
Continuous Head Temperature (Cruise)*	180 C (365 F)
NOTE: * Read Cylinder Head Temp under inner most inlet flange bolt on cylinder # 1. Crimp an 8mm ID terminal to a "K" type thermo couple and place under inlet flange cap screw. Use an alloy washer so as not to tear face of terminal.	

SERIAL NUMBER

Purpose:
Determine engine history and upgrades that may be required.

Engine	Serial Number	Location (pilots view of engine)
R2800	7ANNNNN	In line with the No. 6 cylinder, LHS Mount Plate (part R.147)
R3600	9ANNNNN	In line with the No. 7 cylinder, LHS Mount Plate (part R.148)

NOTE:
A - Alphabetic character
N - Numeric character
Any additional numbers at the end of the serial code signify specific design changes in the engine batch

COOLING SYSTEM

The Rotec Radial engines are “air-cooled.” For any internal combustion engine, an increase in power output results in an increase in heat energy. As Rotec Radials share the cooling of 110hp or 150hp over 7or 9 cylinders respectively, there is far more margin for air-cooling compared to a 6 cylinder engine producing 120hp. In addition, compared to other engine configurations, (i.e. flat, V and straight), the radial configuration offers the greatest frontal area for air-cooling. Even with this in mind, some consideration must be taken to cool the engine properly.

EXPOSED ENGINES:

- Aircraft with exposed engines (without a cowl), boast the lowest cylinder head temperatures
- The only disadvantage to having an exposed engine is a moderate increase in drag

COWLED ENGINES:

- Aircraft with cowled engines require appropriate air outlets, otherwise the engine will overheat. Ignoring fluid compressibility, air can only enter the engine as fast as it can escape. Air outlets can be designed to use the venturi effect, having the outside airspeed draw air from the engine bay.
- Cylinder baffling can be used to encourage air over the cooling fins of both the cylinders and the cylinder heads. We currently do not have prefabricated baffling available.

No inter baffling is required so long as full air stream contacts all heads and cylinder barrels.

NOISE & EMISSIONS

For maximum performance, the Rotec Radial uses an exhaust collector ring, absent of noise or emission control systems by default.

The noise and emissions produced by the engines have not been tested. If these factors are of concern, you can add mufflers or catalytic converters to the exhaust system.

GEAR REDUCTION RATIO

The gear reduction ratio for the R2800 and R3600 engines is 3:2. For example, if the engine is running at 3600 RPM, then the propeller will be rotating at 2400 RPM.

There are no future plans to alter this ratio, as it would require a complete redesign of the engines.

UNIVERSAL ENGINE DATA

CHT (CYLINDER HEAD TEMPERATURE)

Monitoring Status:
- Recommended on a closed cowl aircraft
- Optional on open cowled aircraft. For example Paul's Flybaby, powered by an open cowled R2800 billet head engine, generally flies at 80 knots and has traveled over 700 hours, but he does not monitor cylinder head temperature.

Gauge Range: Approximately 100 °F to 600 °F (38 °C to 315 °C)

Approximate Operating CHTs:
- Exposed Engines:
- < 270 °F (137 °C) @ cruise, 90 °F (32 °C) ambient temperature
- < 240 °F (115 °C) @ cruise, 50 °F (10 °C) ambient temperature
- Cowled Engines:
- As discussed in Chapter # 'Cooling'

Probe / Sensor Location:
- The CHT ring probe is placed under the inner intake M8 screw of the number 1 cylinder head (top cylinder head). A step washer can be used to adapt a larger ring probe to the underside of the screw. M8 socket head cap screws are removed using a 6mm hex key.
- Placing a ring probe under the 12mm spark plug is difficult as it is recessed into the head by a 22 mm (0.866") diameter bore. It may be possible to include a ring probe under the rear spark plug if bent at a 90°.

EGT (EXHAUST GAS TEMPERATURE)

Monitoring Status: Optional, although recommended for determining mixtures when using the Rotec TBI Fuel System.

Gauge Range: Approximately 32°F to 1652°F (0°C to 900°C)

Probe / Sensor Location: Anywhere on the number 1 cylinder exhaust collector ring section (top cylinder). A port needs to be added to accommodate the probe.

INSTALLATION, OPERATION & SERVICE DOCUMENT

The Rotec Radial engine has been carefully engineered and constructed to meet all the performance requirements of the modern aero piston engine.

The following service / operations manual is the result of many hours of testing and observing the Rotec Radials in a range of operating conditions and situations and, therefore, Rotec Aerosport strongly advise strict adherence to the procedures and information supplied in this document.

UN-PACKING & MOUNTING

PACKAGING REMOVAL PROCESS

Each Rotec engine is packaged to enable the safest mode of transportation practically possible. To achieve this, the engine has been placed horizontally with the accessories section facing the base of the container, the centre of gravity is further lowered by the removal of the starter motor, alternator and carburettor; all of which must be refitted prior to operation.

Step 1: Remove screws from lid of container

Step 2: Remove lid from container

Step 3: Remove screws from base of container walls

Step 4: Remove container walls in one piece

Step 5: Remove screws attaching engine block to container base

Step 6: Remove engine from crate bottom with wooden blocks still attached

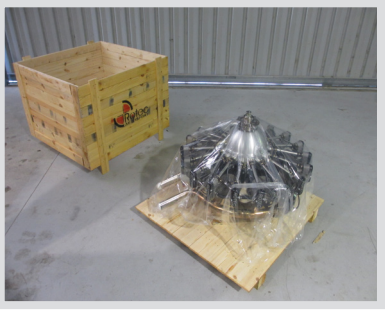
Step 7: Unwrap Engine

Step 8: Remove wooden blocks

NOTE:
It is recommended that you save your container for re-use or storage.

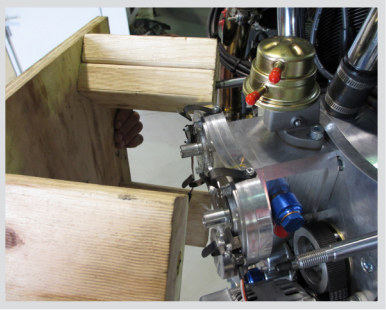




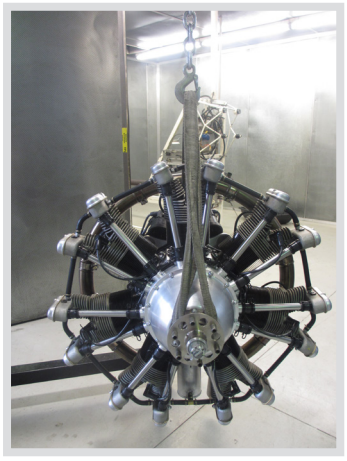




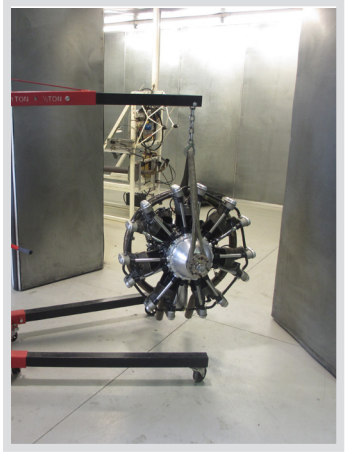



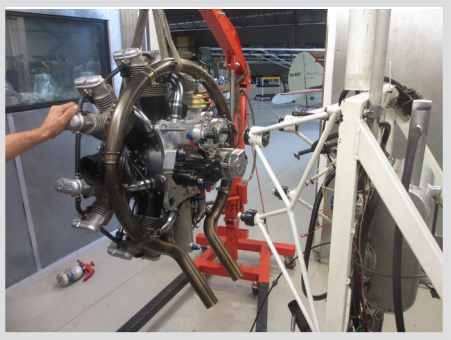
ENGINE MOUNTING PROCESS

Positioned vertically, the resting weight of the engine is distributed via the two lower rocker cover cylinders (to avoid damage, place a strip of plywood or similar between the resting surface and the rocker covers). This will position the #1 cylinder (upper most) dead vertical. The engine can now be hoisted via the inner most exhaust bolt (see below) of the #1 cylinder head. This is the recommended hoisting position.



NOTE:
The sling is the recommended hoisting position due to the ease in which the user can change the attitude of the engine when mounting.





Once the engine is properly positioned on the hoist, the engine can be pushed into position and aligned with the engine mount housing. When the engine has been fastened to the mount, the hoist can be removed.

ENGINE MOUNT FRAME

MANUFACTURED BY ROTEC AEROSPORT

We design and fabricate Rotec Radial engine mounts specifically for your airframe.

Save the time and hassle of doing it yourself. The fastest way and often cheapest way to move your project forward is to have one of our experienced fabrications produce auxiliary components for you.

Just follow these simple steps:

1. Contact Rotec Aerosport via Sales@RotecAerosport.com if you are interested in purchasing one.
2. Fill out the Engine Mount Dimension Form you shall receive via email
3. Send your completed form to our technical department at Technical@RotecAerosport.com. An engineering drawing will be generated and then sent back to you for your approval.*
4. We schedule fabrication once your approval is received.**

***NOTE:**

Deviations from the standard four mount point fixed position design is allowed although this will incur additional costs. This includes swing mounts, three or five point mounts, or non-standard bracing. Free engine mount drawings are offered with the purchase of a new engine if customers wish to fabricate their own.

****NOTE:**

While we have previously designed engine mounts for many aircraft, in order to ensure correct fitments, customers must provide dimensional data and then approve the engineering drawing before fabrication commences. If the mount is purchased with an engine, it will generally be fabricated towards the end of the engine production batch, assuming payment has been received.

DO IT YOURSELF

Some customers choose to fabricate their engine mount themselves. All Rotec Radial engine purchases without an engine mount are provided with specific Rotec hardware to make this process easier (see Figure #).

The following specifications are to be considered when fabricating a Rotec Radial engine mount:

Engine Position:

A Radial engine has a central line 10 - 15cm (4 - 6'') lower than a typical flat engine. Installations replacing a flat engine will look odd if mounted in the same position. Mount the radial engine more centrally on the firewall.

Propeller Ground Clearance:

Some installations will require the engine mount to be closer to the centre of the airframe than usual. As a consequence, the landing gear will need to be lengthened to add more clearance from the ground for the propeller.

Mount Points:

Typically, four connection points to the airframe firewall. Three or five points can be used if desired.

Engine Mount to Airframe Bolt Size:

- Standard - AN6 (3/8'' - 24 Thread)
- Recommended minimum (for a 4 point mount) - M6 or AN4 (1/4'' - 28)

Material:

4130 series steel stainless tube - 5/6'' (16mm) outer diameter x 1/16'' (1.6mm) wall thickness.

Cross Bracing:

Each connection to the firewall requires a cross brace to increase the rigidity of the mount.

Top & Bottom Cross Braces:

The propeller rotates counter-clockwise (viewing from in front of the engine), resulting in an opposing torque on the engine mount. If possible, the members that experience the highest loads should be made from single straight uncut pieces of material so that they experience the compressive forces. These braces are:

- Top Left of the firewall to the Top Right of the engine, viewed from the front of the engine
- Bottom Right of the firewall to the bottom left of the engine, viewed from the front of the engine

Side Cross Braces:

The side cross braces intersection point must be pushed out to a minimum distance of 440mm and 20mm below the engine thrust line (see Figure #). This is to ensure clearance for the starter motor and alternator.

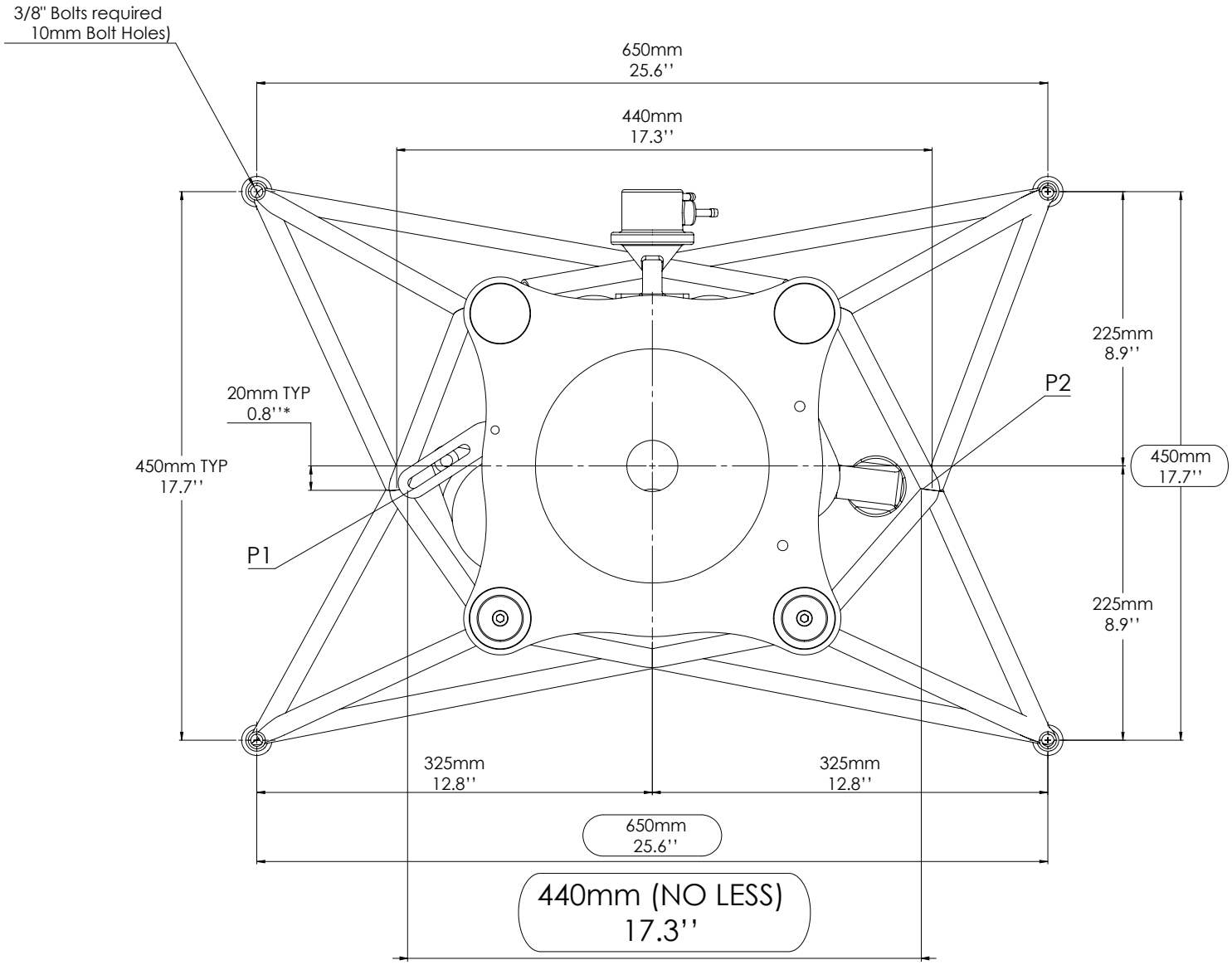
Length:

Distance from the rear of the engine to the firewall is recommended to be greater than 254mm (10'', see Figure #).

- The greater the distance from the firewall, the greater the accessibility to the engine accessories. Any less will make it difficult to remove the distributor caps without removing the engine from the airframe. It may also be difficult to install some induction components, unless the firewall recedes inward at that location.
- Swing mounts and custom made upward draft carburettor manifolds can be used to have the engine mount even closer top the firewall than the recommended distance.

ENGINE MOUNT FRAME

FRONT VIEW



Minimum Distance to ensure that the verticies avoid interefence with the Starter Motor and Alternator.

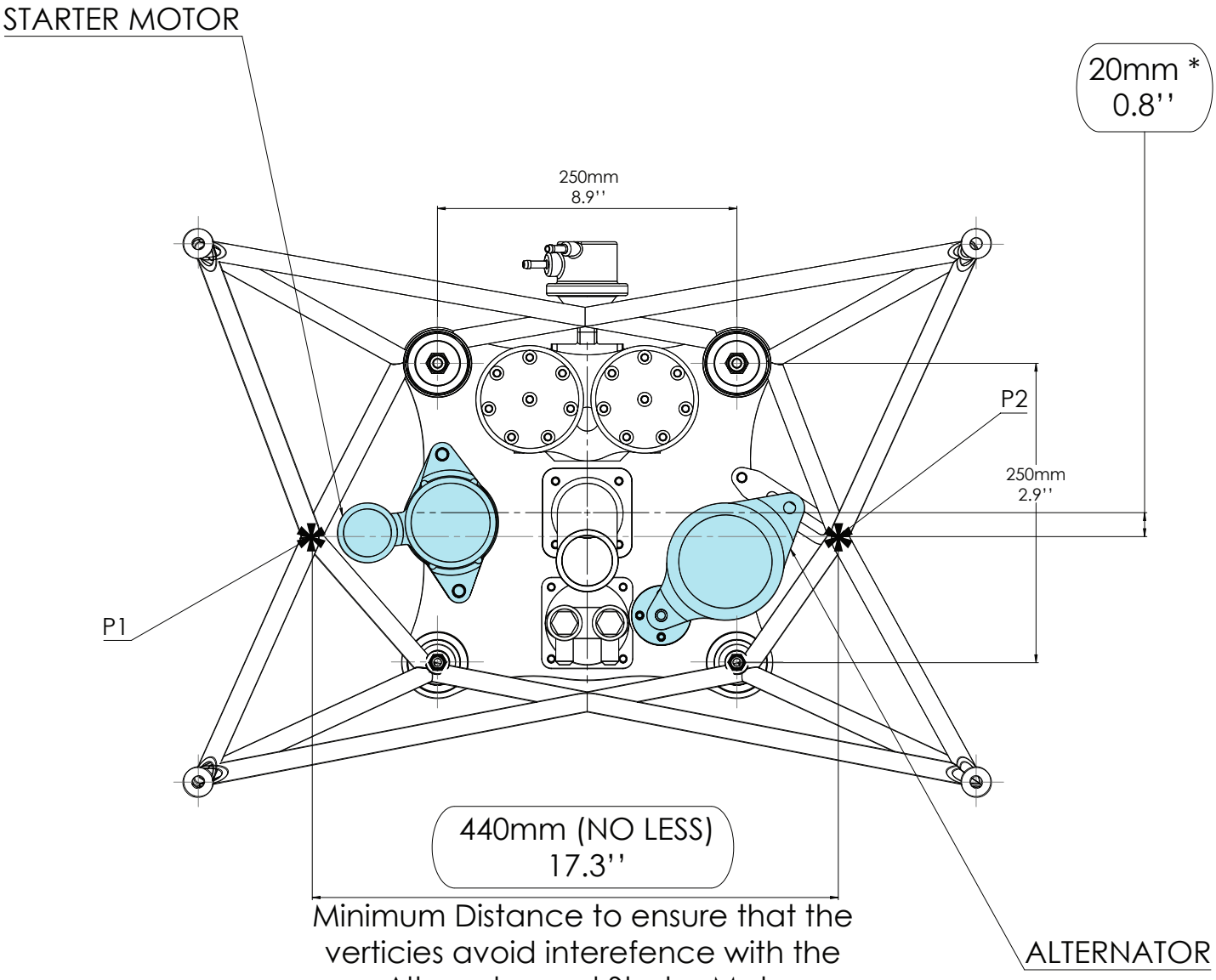
* Mount Verticies (P1 and P2) must be exactly 20mm vertically offset from the centre to avoid interference with the Starter Motor and Alternator.

NOTE:

Typical engine frame geometry. Tubes welded to Standard Rotec Mounting Pins (Supplied). Tubes ½'' OD.

Figure 20. R2800 Engine Mount Dimensioned Front View

REAR VIEW



* Mount Verticies (P1 and P2) must be exactly 20mm vertically offset from the centre to avoid interference with the Alternator and Starter Motor.

NOTE:

Typical Front View of engine frame geometry. Worthy of note is the junction points of the tubes on the top and both sides which must be placed in these positions or better so as to clear the fuel pump (TOP) alternator (SIDE) and starter motor (SIDE). All tubes ½" OD.

Figure 21. R2800 Engine Mount Dimensioned Rear View

ENGINE MOUNT FRAME

SIDE VIEW

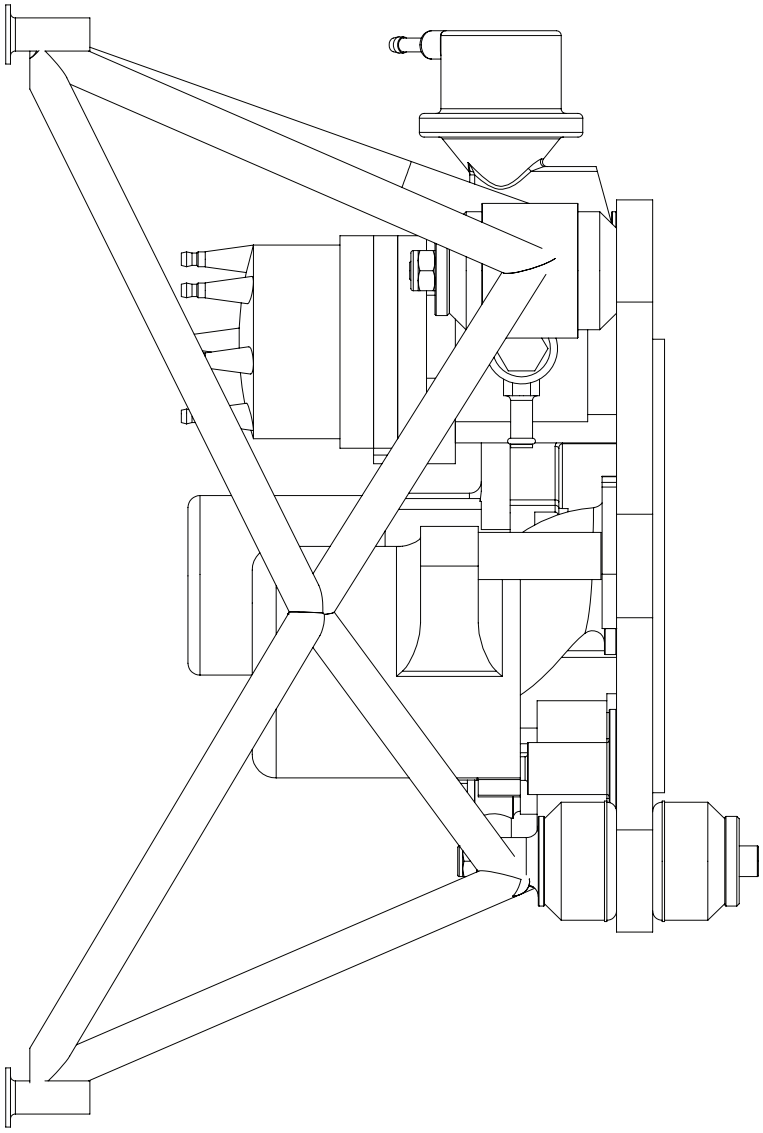


Figure 22. R2800 Engine Mount Side View

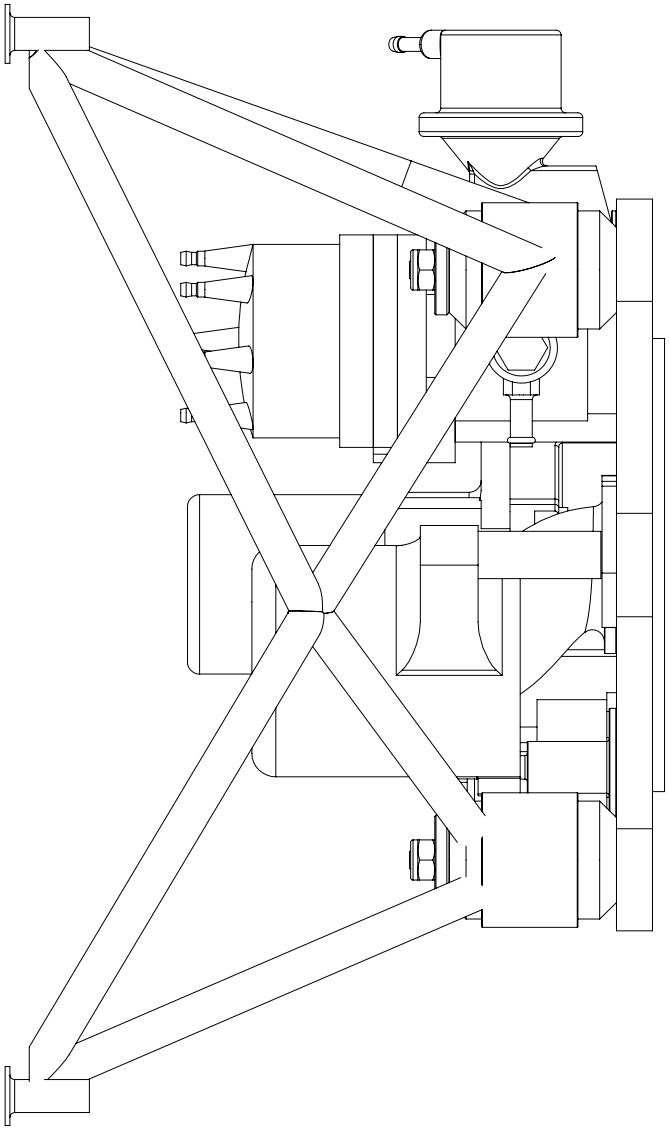


Figure 23. R3600 Engine Mount Side View

NOTE:

Typical engine frame geometry. The stagger pf the upper and lower weldable cup and hollow pin. Tubes ½'' OD.

TOP VIEW

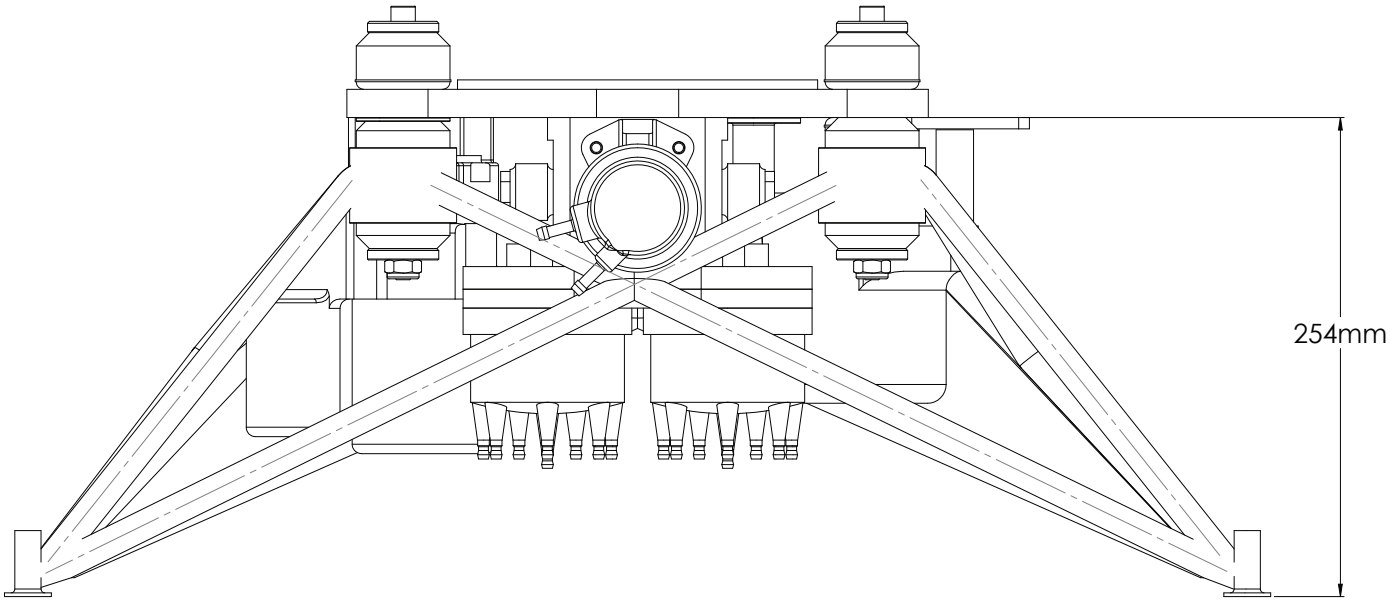


Figure 24. Engine Mount Top View

NOTE:
Typical engine frame geometry. See Rotec cup type mounts welded to frame. Tubes ½'' OD.

ENGINE INSTALLATION

Prior to coupling the engine to the airframe, the starter motor, alternator and carburettor may be fitted, as at this time this is made easier as there is no airframe to avoid, however, it should be noted that these accessories may be fitted at any time as sufficient clearance should be allowed for their serviceability.

The main consideration in the construction of the engine frame should be the clearance of both the starter motor, port side and the alternator on the starboard side.

Special engine mount rubbers, bolts, nuts, bushes and washers are supplied, along with weldable upper cups and lower weldable pins for engine frame attachment.

R3600 & 2800 CUP MOUNTS

See (Figure #) the engine mount assembly (all supplied) the steel centre section is the weldable cup which will be welded to the engine frame. It supports the engine via the four rubber engine mount cushions, the entire assembly is clamped by the machined alloy end washers and M10 Nylok nut. See also the same assembly in an exploded view (Figure #). Note that the assembly will crush the rubber cushions to the correct amount once the metal components have "bottomed out" at a length set by design. Further tightening beyond this point will not increase the crush on the rubber cushions.

R3600 COMPONENTS:

Code:	Name:	Quantity:
R.164.1	Male Rubber Bushes	4
R.164.2	Female Rubber Bushes	4
R.069	Flared Sleeves	4
R.068	Mount Cups	4
R.063.2	Flat Washers	4
NM10N	Nyloc Nut M10	4

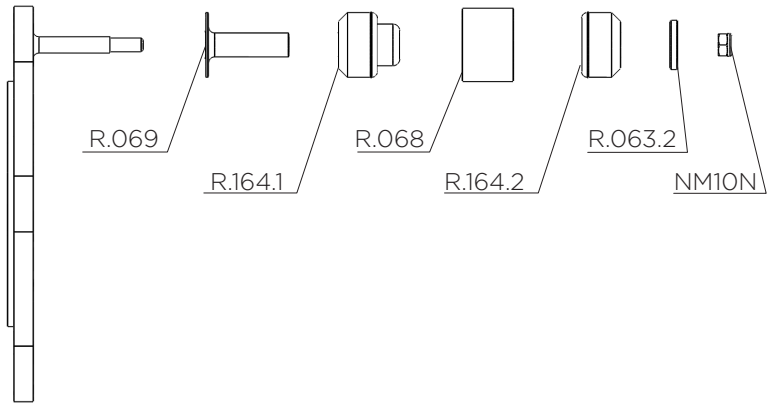


Figure 11. Exploded Engine Mount Cup Side View

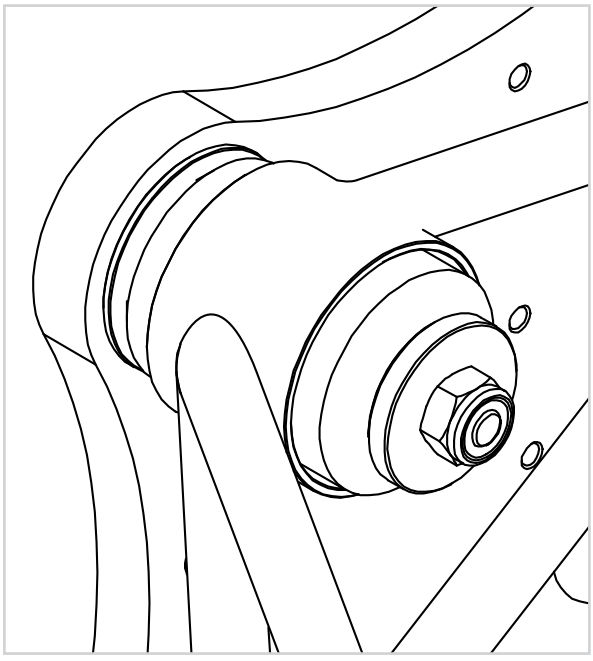


Figure 12. Engine Mount Cup Detail View

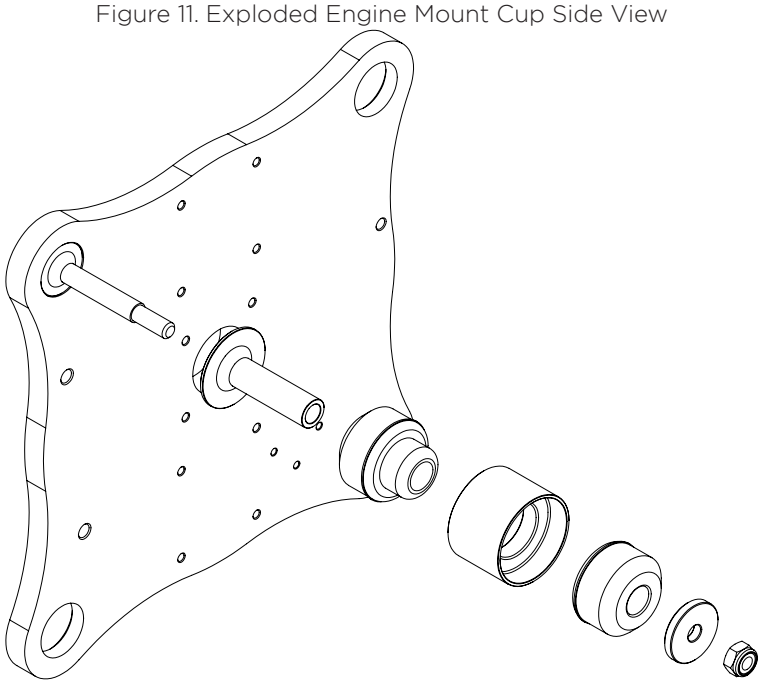


Figure 13. Exploded Engine Mount Cup ISO View

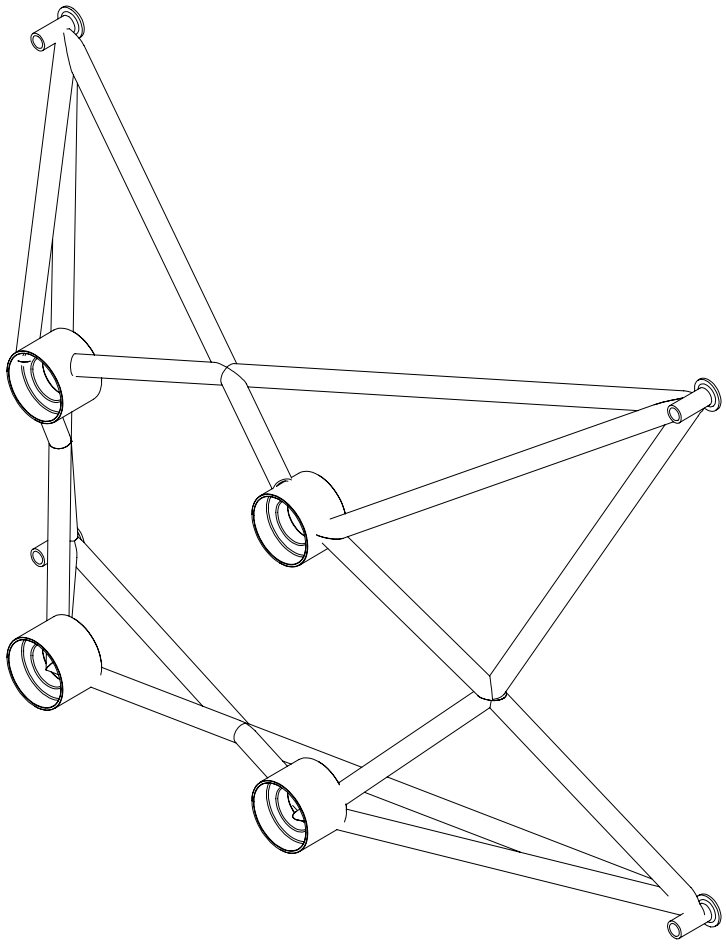


Figure 14. R3600 Engine Mount ISO Front View

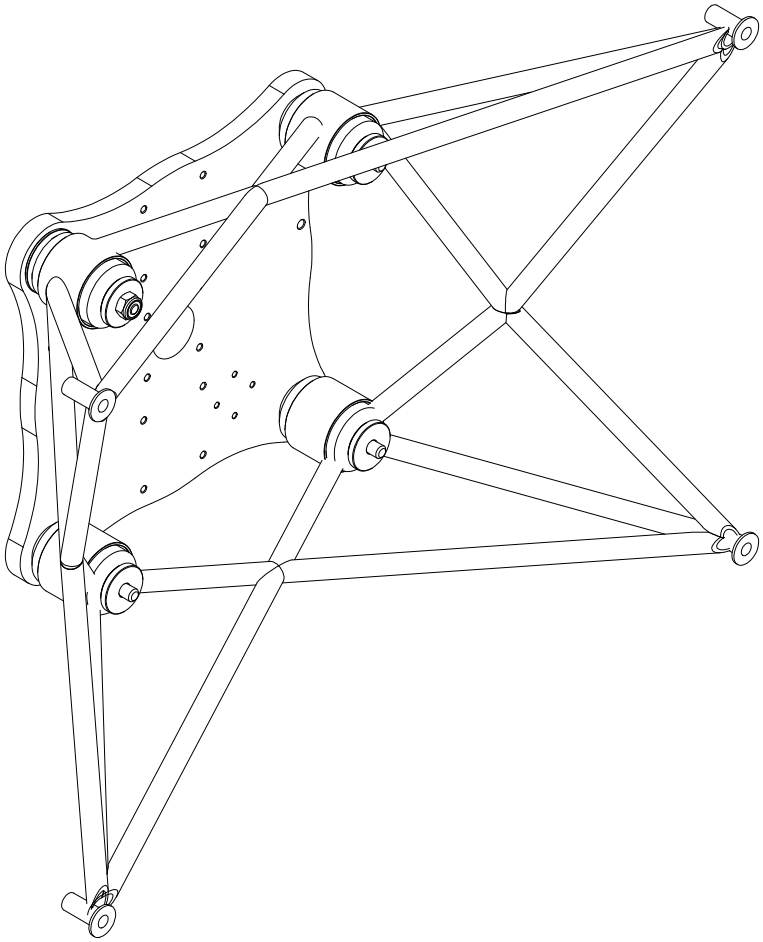


Figure 15. R3600 Engine Mount ISO Rear View

ENGINE INSTALLATION

R2800 LOWER PIN MOUNTS

See also the lower engine mount assembly (all supplied) the hollow weldable pin is welded to the lower portion of the engine frame, the same rubber cushions as used on the top mount are also used . The entire assembly is retained via the machined alloy washer, through bolt and M8 nylock nut. Note that when tightening, the assembly will crush the rubber cushions to the correct amount once the metal componenents have “bottomed out” out at a length set by design. Further tightening beyond this point will not increase the crush on the rubber cushions.

R2800 COMPONENTS:

Code:	Name:	Qty:
R.164.1	Male Rubber Bushes	4
R.164.2	Female Rubber Bushes	4
R.070	Pin	2
R.069	Flared Sleeve	2
R.068	Cup	2
R.063.1	Step Washer	2
R.063.2	Flat Washer	2
NM10N	Nyloc Nut M10	2
NM8N	Nyloc Nut M8	2
SHCSM8120	SHCS M8 x 120	2

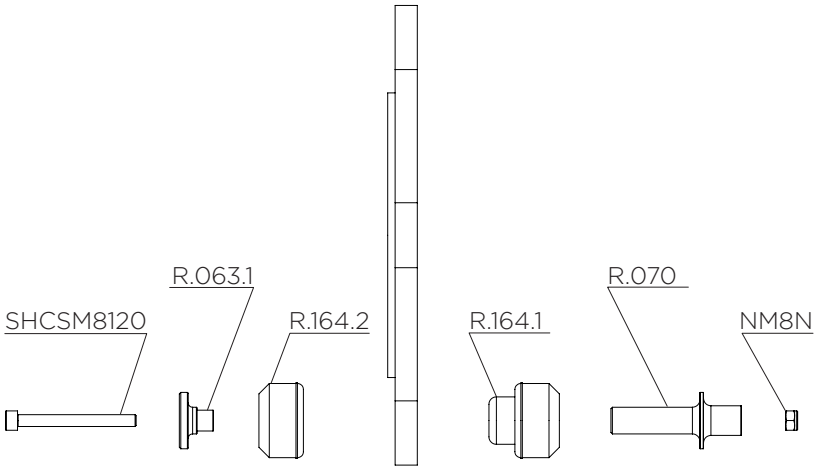


Figure 15. Exploded Engine Mount Pin Side View

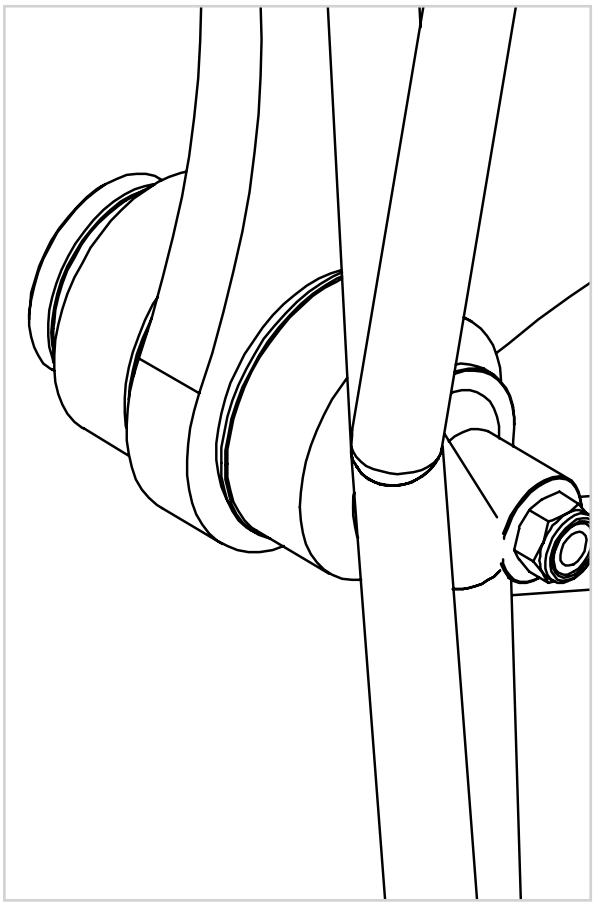


Figure 16. Engine Mount Pin Detail View

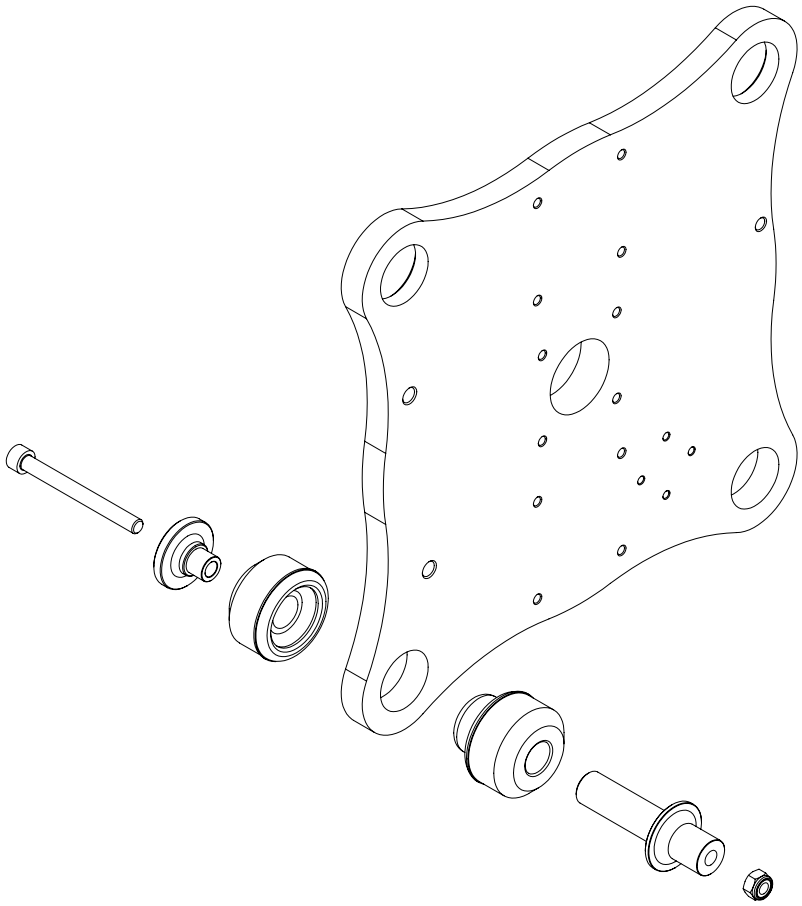


Figure 17. Exploded Engine Mount Pin Side View

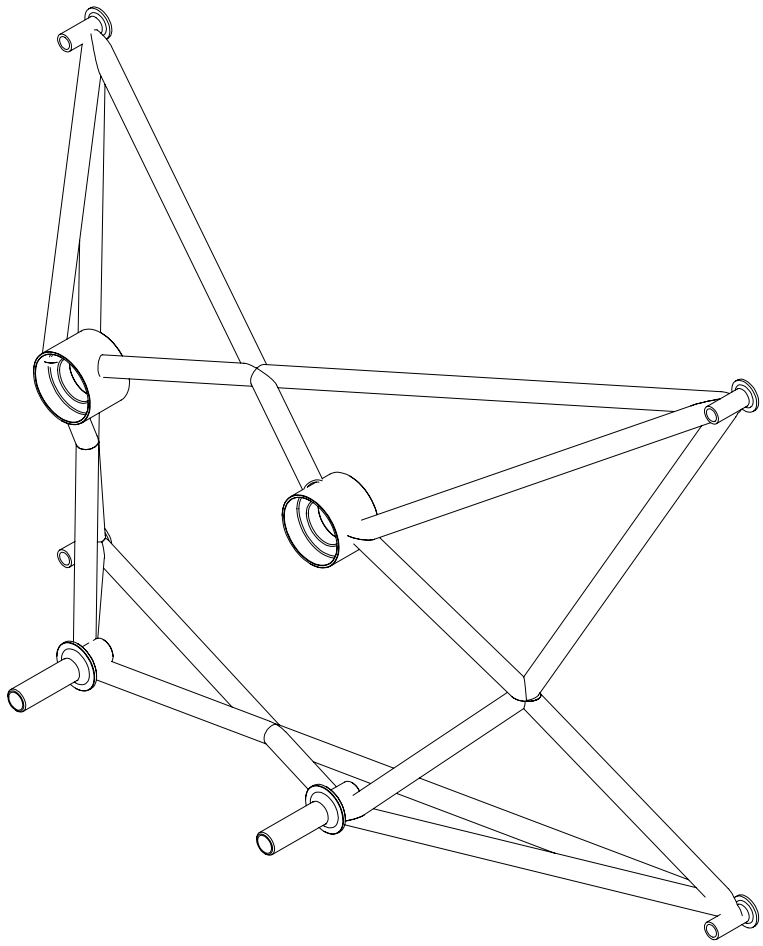


Figure 18. R2800 Engine Mount ISO Front View

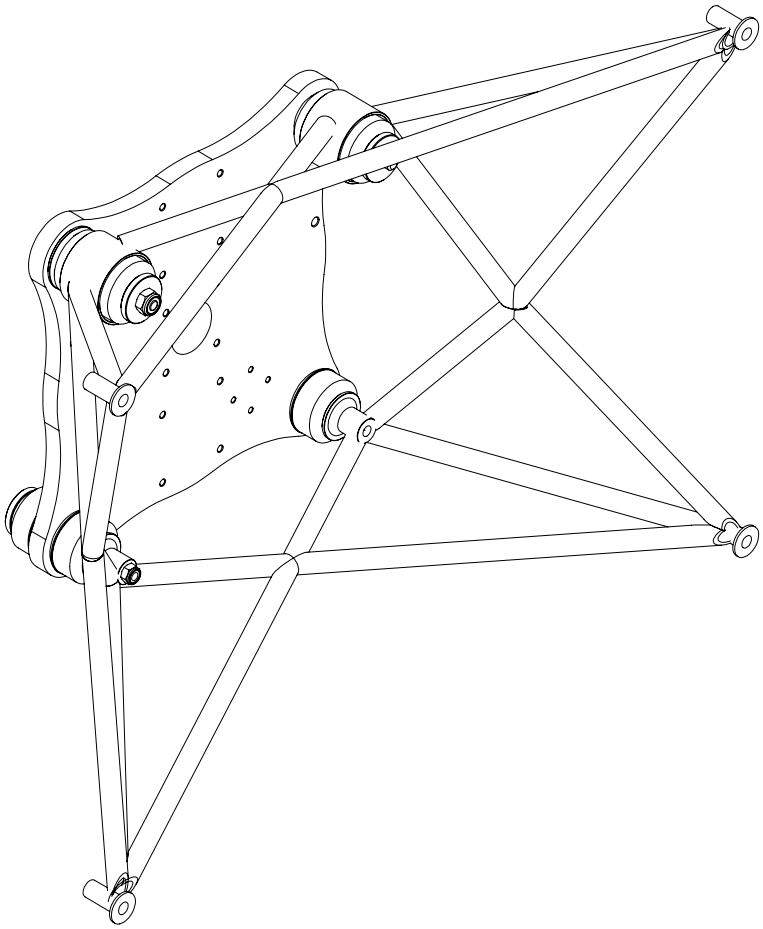


Figure 19. R2800 Engine Mount ISO Rear View

INSTALLING THE ENGINE ON THE FRAME

The engine mount frame attaches to the airframe using engine mount bolts, nuts and washers.

Airframe mount point holes on the engine mount are generally made larger than the size of the engine mount bolts to make fabrication easier. For location purposes, a washer is welded to the base of the mount points to capture the diameter of the bolt.

- If the welded washer ID is less than the OD of the engine mount bolt used, it can be drilled out to an appropriate size.

- If the welded washer ID is greater than the OD of the engine mount bolt used, a step washer can be used to ensure the engine mount is centred correctly to the frame.

INSTALLATION CHECKLIST

NOTE:
Make sure you disconnect the battery before installation the electrical components.

- Disconnect the battery.

- Check the fuel line hose clamp to mechanical pump's tightness
- Check the carburettor hose clamps are tight. Using a 7mm socket on handle often works best.
- Check both of the carburettor linkages are free and have full movement.
- Check the oil line from the filter block to oil inlet between the cylinders is tight at both ends.
- Check the oil line from oil tank to RHS (rear view) of low oil pump is tight.
- Check the oil pump banjos are tight.
- Check both ends of the oil line from the filter block to the remaining banjo fittings on the low oil pump banjo are tight.
- Check that the breather oil hose is clamped securely to the top of the engine mini sump and is tight.
- Check the return oil line from the outlet on the RHS of the upper oil pump leading back to the tank is tight.
- Check the oil hose and in-line oil filter from the base of the mini sump to inlet side of upper oil scavenge pump on the LHS are tight.

- Check you have disconnected the battery.

- Connect the starter motor main battery cable RED power.
- Connect the starter motor earth cable negative battery cable.
- Connect the starter motor solenoid push on terminal.
- Connect the Alternator 'IG' wire to base of terminal (the one with the tie indicator).
- Connect the warning light wire to vertical 'T' terminal of Alternator.
- Connect the main battery 5mm wire to ALTERNATOR.

- Check the Alternator base mount is tight.
- Check the Alternator adjuster is tight.
- Check the Alternator belt is aligned tight and in pulley grooves properly.

- Connect the magneto coil kill wire brown small spade terminal.
- Connect the 3 pin Dean's plug to the RHS distributor lead.
- Connect the centre cap high tension lead to Auto ignition coil.
- Fit the carburettor air cleaner (slide on, no clamps for test ring).

- Check the usage status of both oil filters and replace if required.
- Check both the Distributor brushes for proper length.

- Fit Distributor Caps and make sure all the Distributor Caps are in position.

NOTE:
If Distributor Caps are not down properly, the brush is probably sticking out to far.

- Connect the battery cautiously.

PROPELLER

RECOMMENDED SPECIFICATIONS

Viewed from the front of the engine, the Rotec Radial prop-shaft rotates counter clockwise (CCW). Therefore, a standard orientation propeller is used. This is reversed when the engine is used in pusher configuration.

Engine	Rotec R2800	Rotec R3600
Blades	2	2*
Diameter*	1.93m (76'')	2.13m (84'')
Pitch*	1.40m (55'')	1.40m (55'')

NOTE:
When selecting a propeller with lesser diameter than recommended, an increase in pitch is necessary. For example, a Rotec R3600 with propeller of 78'' - 80'' diameter will need a pitch of 56''.

NOTE:
When selecting a propeller with a pitch greater than recommended, a reduction in propeller diameter is necessary. For example, a Rotec R2800 with a 76'' diameter propeller, with a pitch of less than 53'', will see the engine over speed at WOT.

NOTE:
A three blade, wood laminated, 68'' diameter, 82'' pitch propeller has been successfully used on a Zenith CH 200.

PERFORMANCE BY POWER SETTING

Rotec Radial Power Setting	Target Engine RPM*	Target Propeller RPM
100% (Static)	3000 - 3100	2000 - 2067
100% (Take Off)	3250 - 3350	2167 - 2233
75% (Crusie)	3000 - 3250	2000 - 2167

NOTE:
Using a recommended propeller, will see the engine work in its target performance range. Engines should not exceed approximately 3500 RPM with a propeller mounted, as going any higher will only result in the blades 'slapping' the air (2333 propeller RPM)

MOUNTING BOLTS

To avoid confusion and waste, propeller bolts are not supplied with new engines. There is no standard propeller thickness and therefore no standard propeller bolt length.

Propeller Bolts Required:
- R2800 - 6 x Metric M8 x 1.25
- R3600 - 6 x Imperial 3/8-24 UNF

Propeller bolt torque settings are to be recommended by the propeller manufacturer. Torque specifications are dependent on the propeller material and thickness. For more information on propellers bolt torque specifications, contact the manufacturer.

Corrosion Resistance:
- Propeller drive dowels (lugs) - case hardened
- Propeller hub - electroless nickle plated

PROPELLER MANUFACTURERS

Rotec does not supply aircraft propellers. We can recommended the following manufacturers and you are welcome to source your own.

For more information on propellers, try:

Culver Props - Valley Engineering
http://www.culverprops.com/contact.php

Whirl Wind Propellers
http://whirlwindpropellers.com/aircraft/

LUBRICATION SYSTEM / PLUMBING

GENERAL

As with all piston engines, the lubrication system is the lifeblood of the Rotec Radial and, therefore, it is critical that the correct fluid dynamics are achieved for engine survival and longevity.

OIL TANK

The Rotec Radial utilises a full dry sump lubrication system and, as a result, requires the use of an oil tank, which is mounted separately from the engine. The oil tank construction is the responsibility of the aircraft manufacturer and should be designed within the parameters of the airframe, which, of course, will vary for each machine.

BASIC DESIGN REQUIREMENTS

1. Have an oil capacity of 6-8 litres or more of oil with a minium usable level of 3 litres.
2. An air pocket above the oil level of approx. 20%. This is allocated as an area for the expansion and over fill of oil and is where the scavenge pump, oil pressure relief, and crank case vents all return oil to.
3. Oil Tank to be mounted slightly above CL of lower oil pump. With aircraft in static position. This allows for a head of oil to be present at the inlet of oil pump.
4. Various fittings on the tank for:

- (A) Oil pressure relief valve return 3/8 nipple for hose clamp attachment fitted to high point on tank.
- (B) Crank case vent. 3/8 nipple, hose clamp attachment fitted to high point on tank.
- (C) Crankcase scavenge pump return. 3/8 nipple, hose clamp attachment fitted to high point on tank.
- (D) Oil tank breather. 3/8 nipple vented to atmosphere, fitted to very highest point on tank or if higher than tank fit to oil filler cap.
- (E) Oil drain sump plug tapped into very lowest point on tank.
- (F) Oil pump suction pick up AN fitting to suit 3/8 ID hose, mounted slightly above lowest point on tank so as to avoid sedimentary debris.
- (G) Oil temperature sender mounted to lowest point on tank (could also be used as sump plug).
- (H) Oil filler port and cap. Could also incorporate tank vent as described in (E).

WARNING!

The above mentioned oil tank does not facilitate inverted flight or negative gravity operation!!!! Oil starvation for just a short period can cause engine failure and or permanent engine damage.

OIL TANK BY ROTEC AEROSPORT

We design and fabricate Rotec Radial oil tanks, specifically to suit your airframe.

Save time and the hassle of doing it yourself. The fastest and often cheapest way to move your project forward is to have our experienced fabricators produce auxiliary components for you.

Just follow these simple steps:

1. Contact Sales@RotecAerosport.com for pricing information.*
2. Fill out the Oil Tank Dimensions Form that will be sent to you.
3. Send your completed form to Technical@RotecAerosport.com. An engineering drawing will be generated and then sent back for your approval.
4. Once your approval is received, fabrication will be scheduled.**

***NOTE:**

Rotec do not supply oil tanks that allow inverted use. Deviations from the standard top mount and side mount designs incur additional costs. For customers who have purchased a new engine and wish to fabricate their own, and oil tank design is offered free of charge if requested.

****NOTE:**

While we have designed oil tanks for many aircraft, each is different and in order to ensure correct fitments, customers must provide dimensional data and then approve the engineering drawing before fabrication commences. If the mount is purchased with an engine it will generally be fabricated towards the end of the engine production batch, assuming payment has been received.

OIL TANK DO IT YOURSELF

Some customers choose to fabricate their oil tanks themselves. The following specifications are to be considered when fabricating a Rotec Radial oil tank.

Minimum Recommended Capacity:

- Rotec R2800 - 8L (2.11 US gal)
- Rotec R3600 - 10L (2.64 US gal)

Material:

- Composition - Aluminium 5005-H34, 5052-H32 or equivalent
- Thickness - 2 to 3mm (14 to 12 gauge) sheet

Connections: See Figure

- 4 (or 5) x Return Lines:
- Size - 3/8'' NPT Threaded Ports*
- Location - Above the oil level. A diffuser can be installed to ensure the oil does not foam with the air
- Return ports needed are:
- Mechanical scavenger pump
- Electric scavenger pump (optional)
- Mini sump breather return
- Oil pressure relief valve return
- Breather to atmosphere (baffled away from other ports)

- 1 x Oil Outlet
- Size - 3/8'' NPT Threaded Port*
- Location - Underside

- 1 x Oil Temperature Sender
- Size - 1/4'' NPT Threaded Port
- Location - Low so that it is submerged in oil at all times

- 1 x Oil Drain Sump Plug
- Optional, most customers omit this and just disconnect the outlet when draining
- Size - As available. Rotec uses M16 Magnetic sump plug
- Location - Underside, so that as much oil as possible can drain out

- 1 x Oil Filter Neck & Cap
- Size - as available
- Location - Top

Mounting Method:

There are many different methods of mounting your tank to your airframe. The most common is to mount directly to the firewall via tabs that extend from the flat face.

Some alternatives are:

- Using Straps
- Using L brackets to join the tank to the firewall
- Welding directly to the frame

NOTE:

If desired to accommodate AN6 fittings, threaded ports can have alternative NPT sizes such as 1/4''. The base design uses larger 3/8'' ports as they are easier to weld to the tank.

LUBRICATION SYSTEM / PLUMBING

OIL TANK BASIC DESIGN REQUIREMENTS

1. Have an oil capacity of 6-8 litres or more oil with a minimum usable level of 3 litres.

2. An air pocket above the oil level of approx. 20%. This is allocated as an area for the expansion and over fill of oil and is where the scavenge pump, oil pressure relief and crank case vents all return to.

3. Oil Tank is to be mounted slightly above the CL of lower oil pump. With aircraft in static position. This allows for a head of oil to be present at the inlet oil pump.

4. Various fittings on the tank for:
   - (A) Oil pressure relief valve return 3/8 nipple for hose clamp attachment fitted to high point on tank
   - (B) Crank case vent. 3/8 nipple, hose clamp attachment fitted to high point on tank
   - (C) Crankcase scavenge pump return. 3/8 nipple, hose clamp attachment fitted to high point on tank
   - (D) Oil tank breathe. 3/8 nipple vented to atmosphere, fitted to very highest point on tank or if higher than tank fit to oil filler cap
   - (E) Oil drain sump plug tapped into very lowest point on tank
   - (F) Oil pump suction, pick an AN fitting to suit 3/8 ID hose, mounted slightly above lowest point on tank so as to avoid sedimentary debris
   - (G) Oil temperature sender mounted to lowest point on tank (could also be sued as a sump plug)
   - (H) Oil filler port and cap. Could also incorporate tank vent as described in (E)

WARNING:

The above mentioned oil tank does not facilitate inverted flight or negative gravity operation. Oil starvation for just a short period of time can cause engine failure and/or permanent engine damage.

ENGINE CONNECTIONS

See Rotec Radial Oil Circuit Schematic (Figure #)

Engine Oil:
- Inlet - AN6 fitting bottom RHS, viewed from the front of the engine
- Outlet - AN6 fitting on the bottom of the mini sump

Oil Pump (Mechanical):
- Location - 6 o'clock position, viewed from the rear of the engine
- Inlet - LHS AN^ fitting
- Outlet - RHS AN6 fitting

Scavenger Pump (Mechanical)
- Location - 12 o'clock position, viewed from the rear of the engine, embedded in the distrivutor assembly
- Inlet - RHS AN6 fitting
- Outlet - LHS AN6 fitting

Auxiliary Scavenger Pump (Electrical):
- Optional Upgrade: Recommended to remove excess oil quickly after shutdown or prolonged standing
- Location - Airframe mounted

Oil Filter Block:
- Location - Airframe mounted
- Sensors (Both 1/8'' NPT):
- Oil Pressure Warning Light
- Oil Pressure Sender - Pressure: 300 to 350 kPa (43 to 50 psi) at cruise (3200 engine RPM)

ENGINE OIL RECOMMENDATIONS

Cooling:	Not Required
Filter:	Use auto type (supplied).
Grade:	15W - 50
Brands:	Oils that contain additives required by the Rotec PSRU, include but are not limited to:
	AeroShell Multigrade W 15 W 50
	AeroShell Oil Sport Plus 4 (alternative option, used by Rotax 912 engines)
	Shell ADVANCE VSX 4 10W-40 for cold conditions where oil temp will be lower than 120C
	Shell ADVANCE VSX 4 15W-50 for standard operating conditions where oil temp will be above 120C
	Castrol GPS (4 stroke bike oil) 10W-50*

NOTE:

* As a general guide, Rotec use Castrol GPS 10W-50 grade oil for all testing year round in Melbourne (Australia) which falls into the Temperate zone 10-40C.

OIL SPECIFICATIONS

Rotec recommends using a high quality, major brand, 4 stroke motorcycle oil with gear additives and “SF” or “SG” API classification.

The gear additives are required to withstand the high stresses in the reduction gearbox. High performance bike specification is recommended.

OIL TYPES

Users running leaded AVGAS more than 30% of the time should only use semi-synthetic oils, since a full-synthetic oil can sludge and create lead residues.

OIL CHANGES 25 HOURLY

WARNING:

USERS SHOULD **STRICTLY** CHANGE OIL AND **BOTH** (2) OIL FILTERS EVERY 25 HOURS. THIS WILL KEEP ENGINE CLEAN, FREE OF CORROSION, AVOID GALLERY BLOCKAGES AND KEEP OIL LUBRICITY EFFECTIVE.

OIL COOLER

Not Required.

All testing conducted by Rotec Aerosport have permitted the exclusion of an oil cooler.

GENERAL RECOMMENDATION

- Shell Advance VSX4 10W-40 for cold conditions where the oil temp will be lower than 120 C
- Shell Advance VSX4 15W-50 for standard operating conditions where the oil temp will be above 120 C
- Castrol GPS (4s stroke motorcycle oil) 10W-50

NOTE:

As a general guide, Rotec uses Castrol GPS 10W-50 grade for all year round testing in Melbourne, which falls into the Temperate 10-40C zone.

OIL VISCOSITY

A multi-grade oil is recommended. Refer to Figure # to select the appropriate viscosity for your climate.

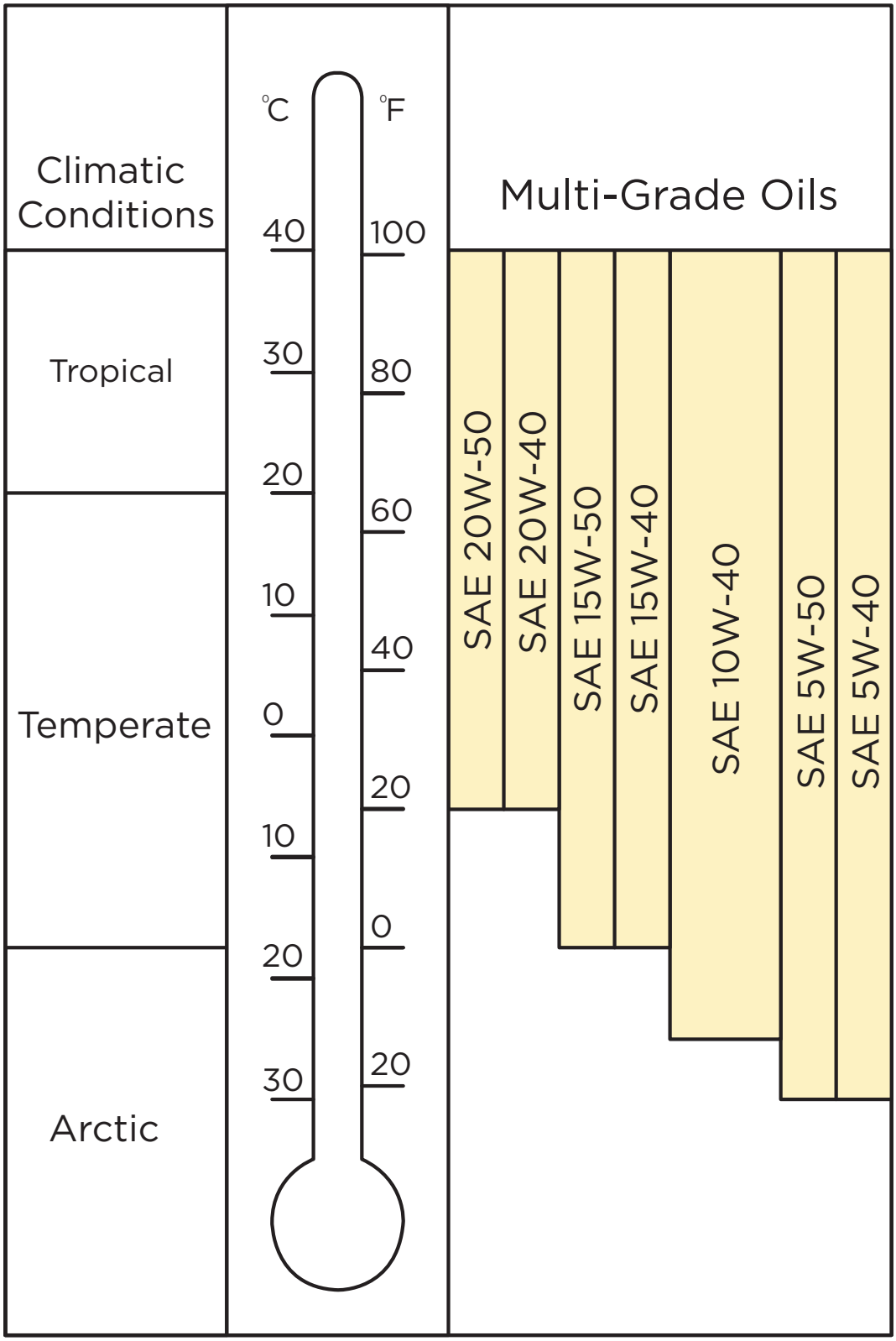
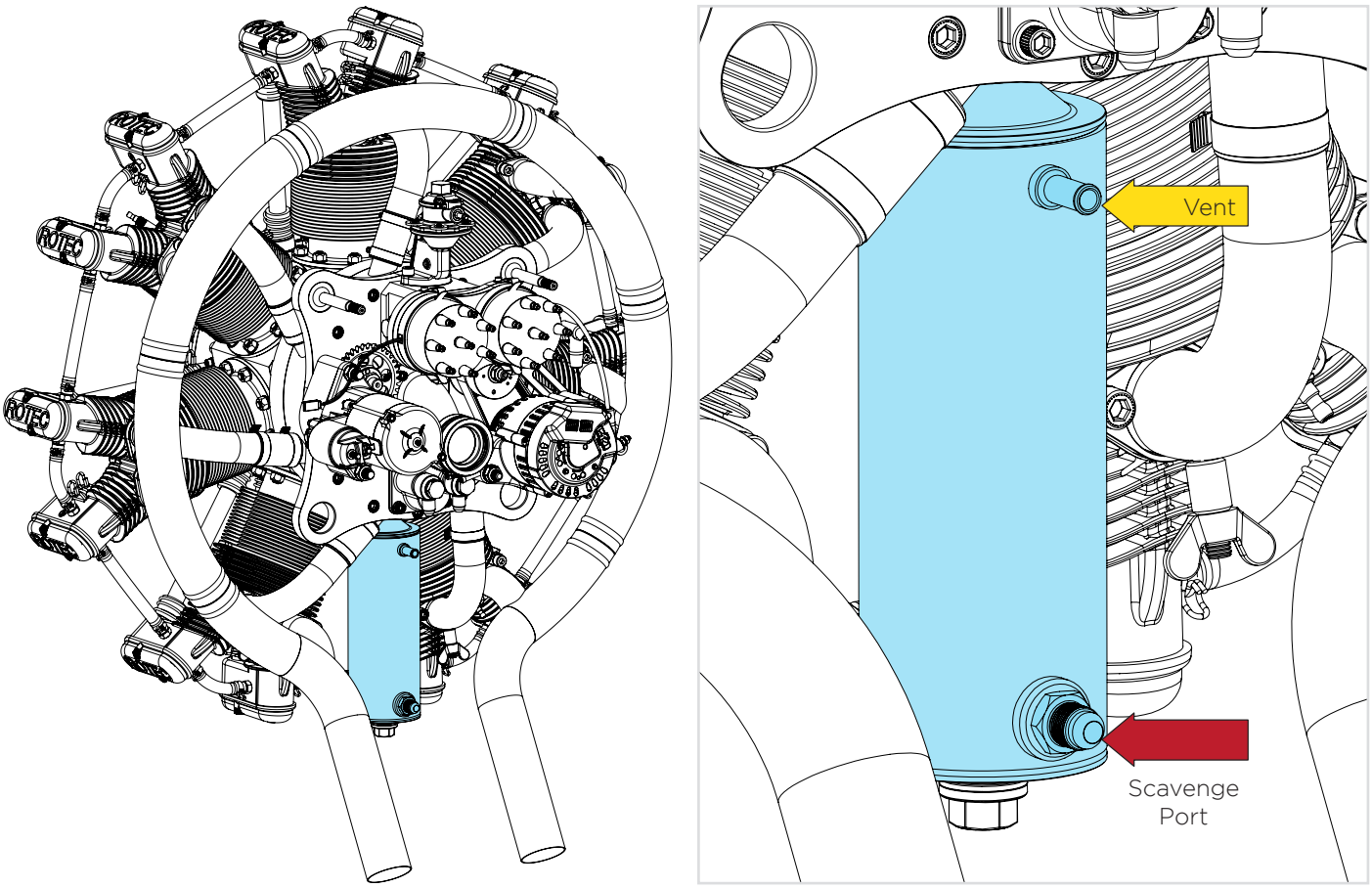


Figure #. Selection of oil viscosity based on climate conditions.

OIL LINES & WHERE THEY GO

The lubrication plumbing is described here with frequent references to numbered illustrations which should aid the understanding of what hose goes where and why. The logical way to describe the plumbing connections is to follow in sequence the path the oil travels from its starting point (scavenge sump) to its destination (oil tank and back to engine intake).

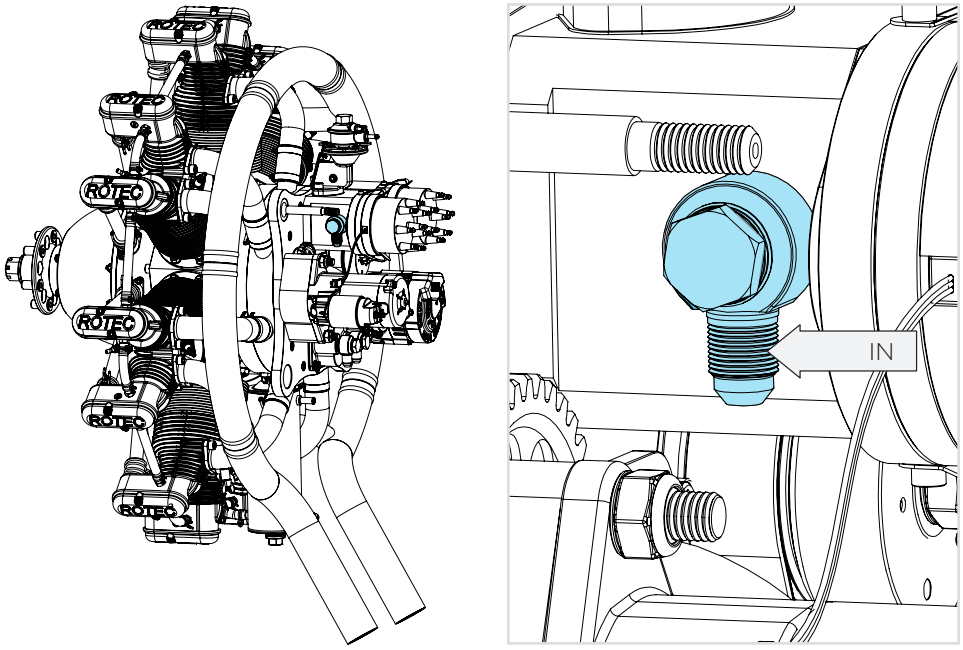
1. The oil leaves the engine from drain ports located beneath the engine. Oil drains down and fills the cylindrical scavenge sump located between the two lower cylinders. The upper most connection is the crankcase vent nipple (yellow arrow) and should be connected to the highest point of the main oil tank where oil will be separated from the air to then vent via the main tanks vent out let pipe to atmosphere. A low pressure 3/8 ID hose is hose clamped connected at each end. (See fig. 25.)



(Figure 25. Red arrow AN (5/16" OR 3/8" ID) pick up to main scavenge pump.
Yellow arrow to vent on main oil tank.)

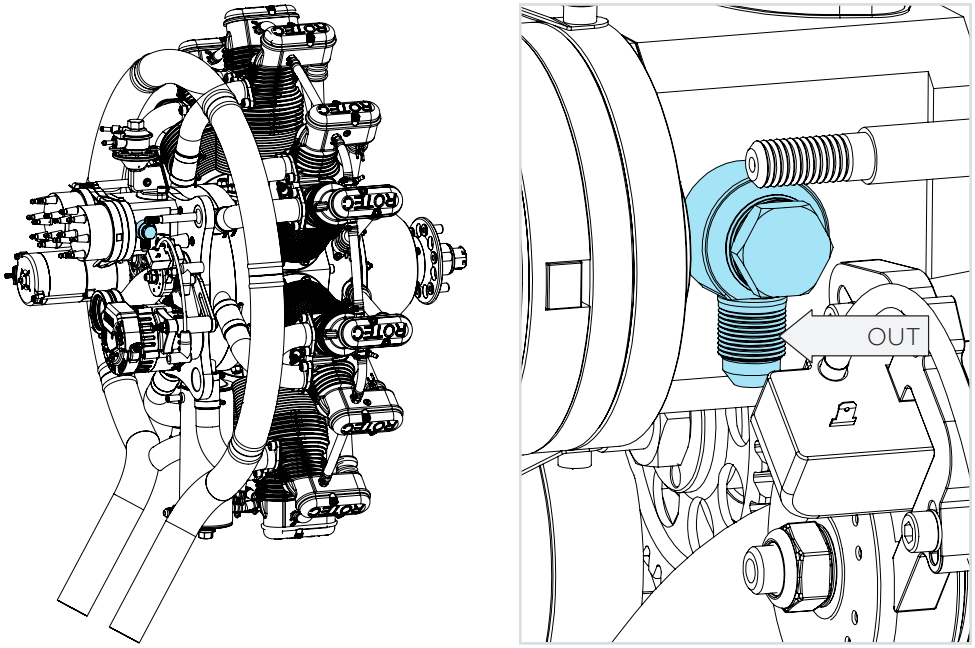
LUBRICATION SYSTEM / PLUMBING

2. The lower fitting on the sump (Fig 25. Red arrow) is the main oil scavenge exit and is connected to the suction or port side of the scavenge pump (Fig 26.)



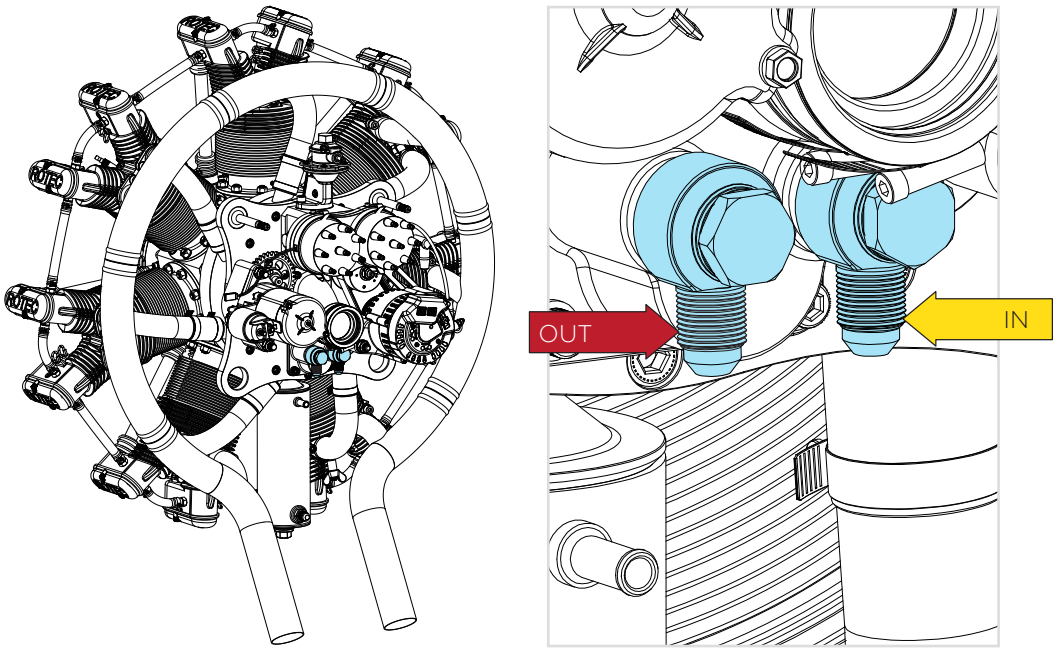
(Fig. 26. Scavenge pump suction port IN)

3. The oil then exits the same pump on the starboard side of the scavenge pump (Fig. 27.) where it then connects to a nipple mounted in a high position on the main oil tank.



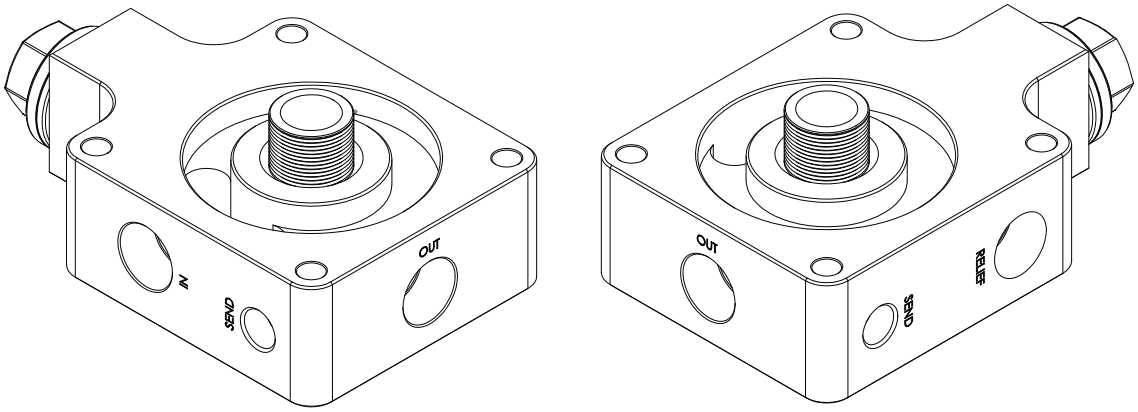
(Fig 27.. Scavenge pump exit OUT fitting en-route to tank)

4. Now that the oil has been returned to the main oil tank via the scavenge pump it is now waiting to be pumped back into the engine by the pressure pump located low under the intake manifold casting. A hose fitted to the lowest point of the oil tank supplies oil to the inlet suction side (yellow arrow) of the pressure pump (Fig 28.).



(Fig. 28. Inlet side Yellow arrow. Outlet side Red arrow)

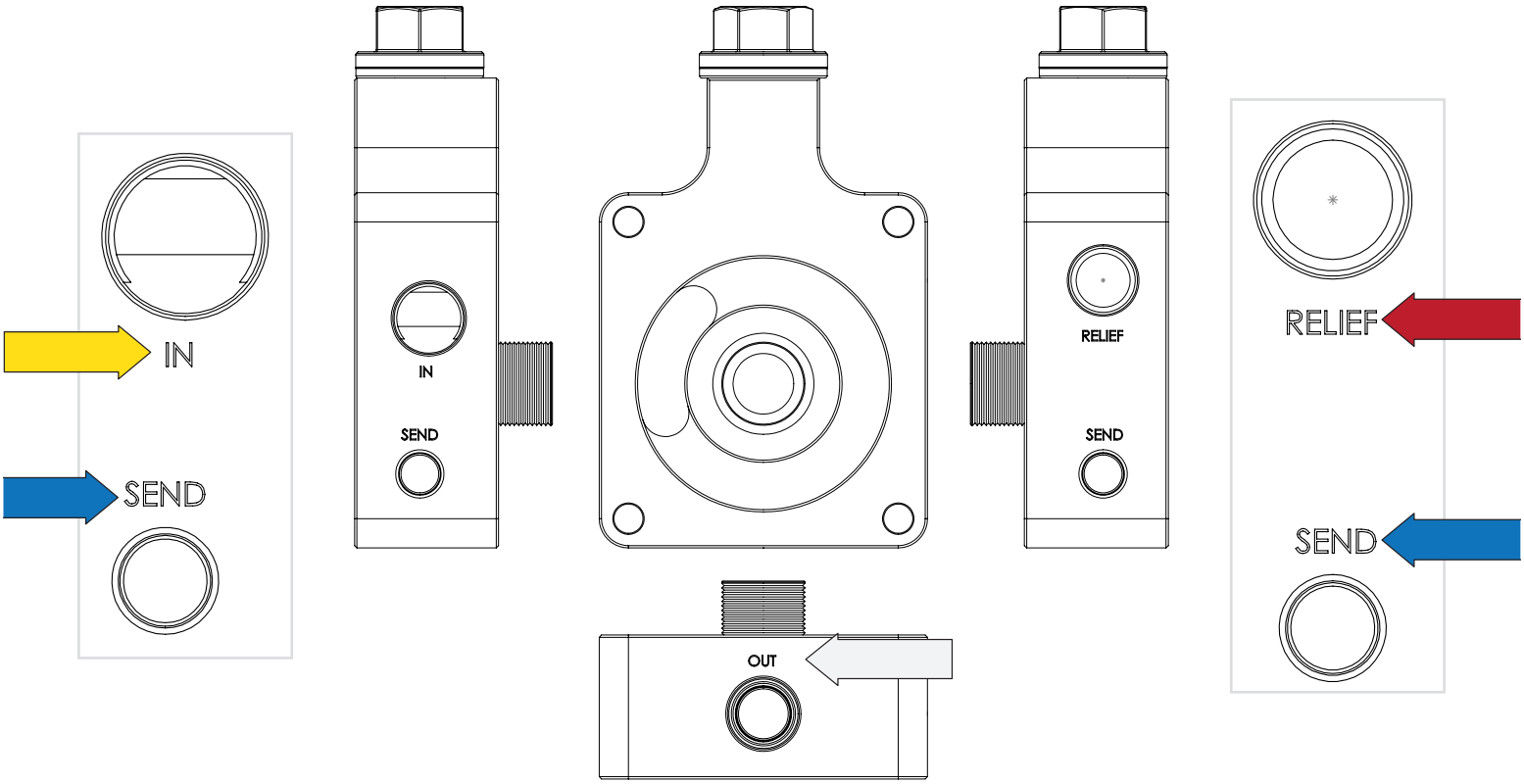
5. The oil then exits the pressure pump from it's port side fitting (fig 28. Red arrow) a hose connects this fitting to the three way oil filter / relief valve body (fig 29.) which is remotely mounted as close to the engine as practicality possible (eg. fire wall).



(Fig. 29. Oil filter/ relief valve block and standard AN fittings)

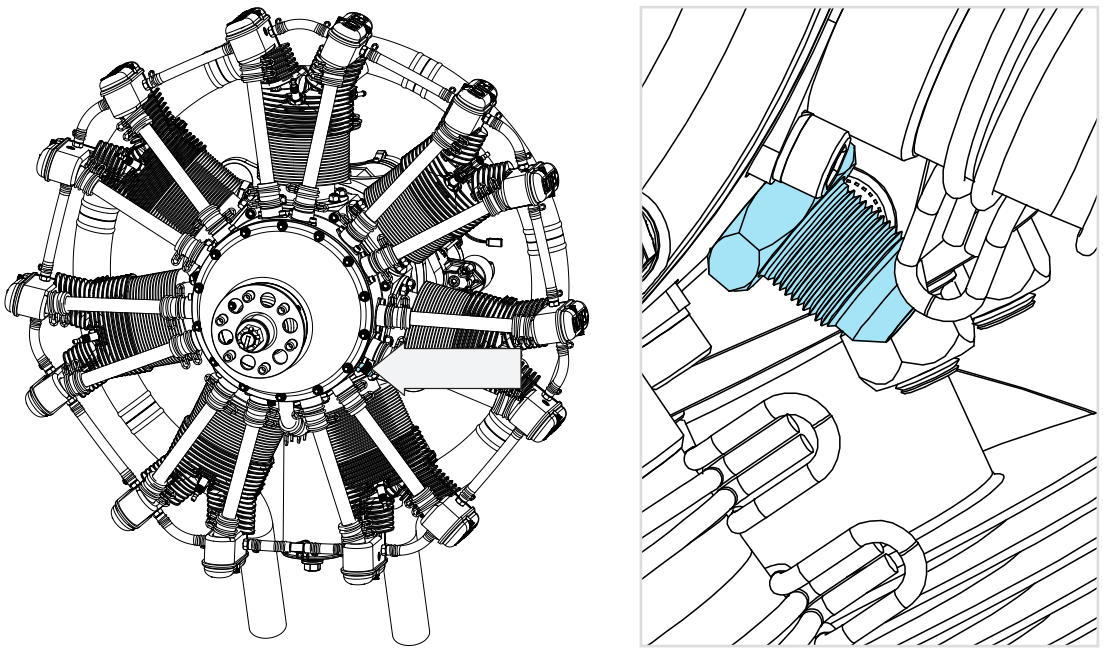
NOTE:	
Oil Filter Block Threads	
Large Diameter Hole	3/8 NPT
Small Diameter Hole	1/8 NPT

LUBRICATION SYSTEM / PLUMBING



(Fig. 30. Oil filter/ relief valve block and standard AN fittings detail view)

6. Oil enters the inlet side (yellow arrow) of the filter / relief valve (fig. 30) where it is not only filtered but also it's pressure regulated by the relief valve. The relief valve relieves excess oil pressure back to the main oil tank via the fitting indicated by the red arrow. The remaining oil pressure exits the unit via the lower fitting indicated by the white arrow where it then finally connects to the engine via a fitting located between cylinders #5 & 6. (Fig 31.) Note also the two blue arrows these are indicating the positions for the VDO oil pressure sender and the VDO oil pressure warning light / engine hour switch.



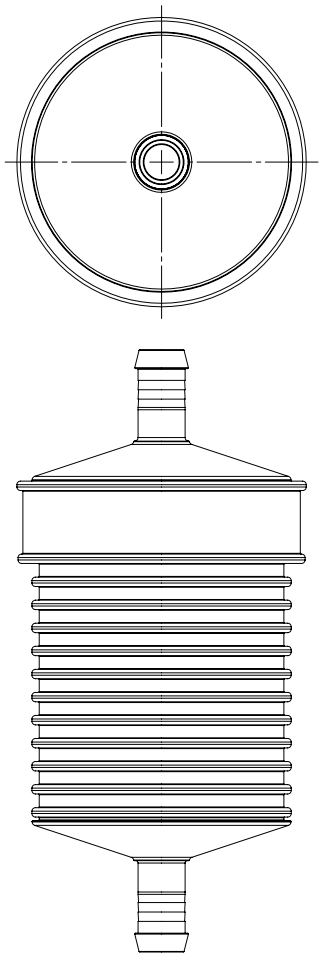
(Fig. 31. Final oil pressure inlet fitting AN type for 3/8" ID hose)

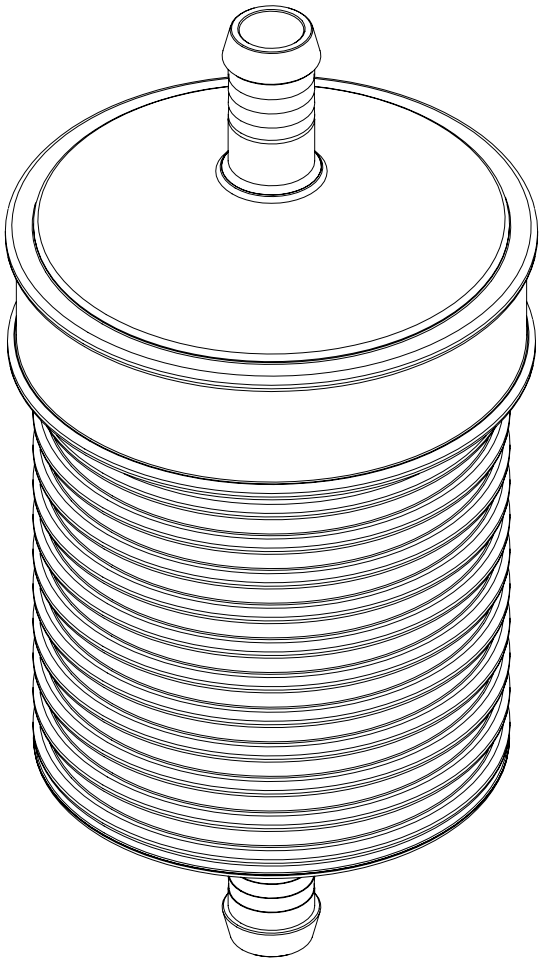
IN LINE SCAVENGE PUMP FITTMENT

Rotec radial engines require the use of an in-line filter to the suction hose between the mini collector sump and the main scavenge pump inlet. The filter can be mounted in alternate positions other than shown in (Figure #.) but must always be mounted in series before the gear pump inlet. The filter is required to stop unwanted “bed in” debris being drawn in through the unfiltered scavenge pump gears. No oil can actually enter the engine unfiltered due to the main oil filter, but without the in-line filter, oil could be drawn from the engine unfiltered through the scavenge pump. The hose length should be as short as reasonable. Excessive routing of hose is undesirable as this could affect the flow rate of the oil returning to the main tank.

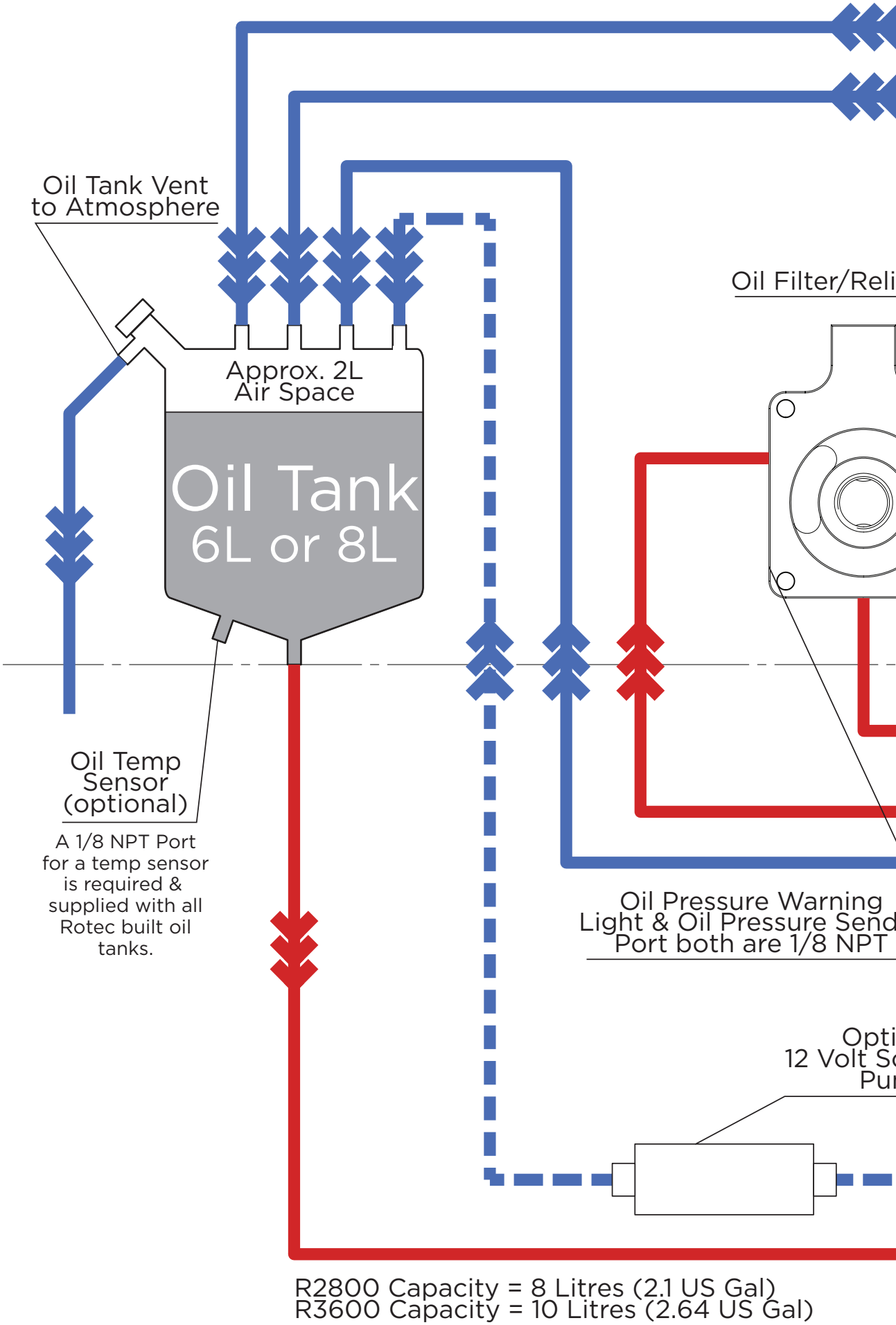
NOTE:

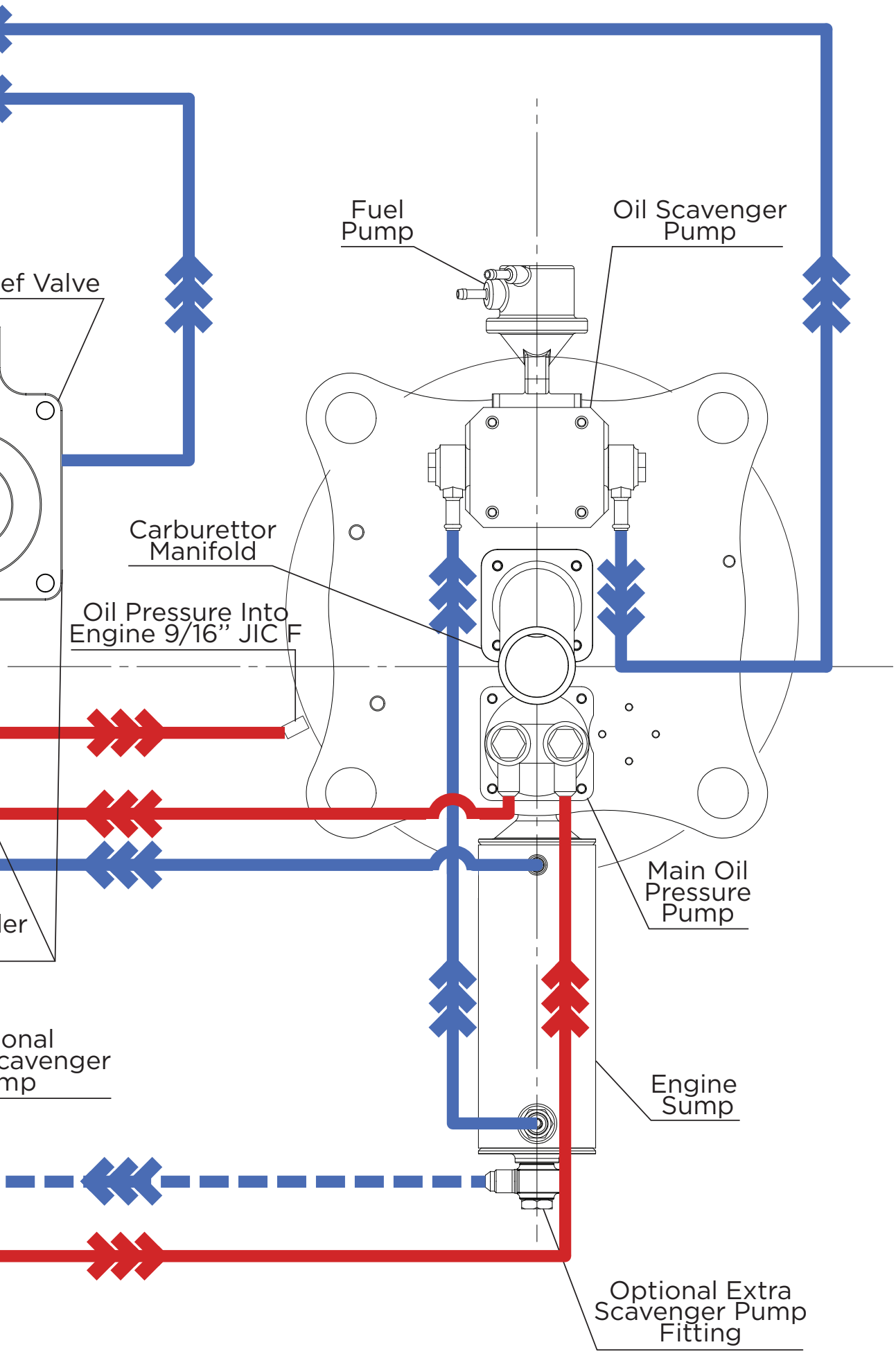
The ‘‘scavenge filter’’ should be replaced every 25hrs to be safe. A blockage or high resistance could adversely affect the lubrication system causing possible oil starvation. This is a low pressure application, so hose clamp attachments are acceptable.





OIL FLOW SCHEMATIC




Fuel Pump
Oil Scavenger Pump
ef Valve
Carburettor Manifold
Oil Pressure Into Engine 9/16" JIC F
Main Oil Pressure Pump
ler
onal cavenger mp
Engine Sump
Optional Extra Scavenger Pump Fitting

ELECTRICAL SYSTEMS

GENERAL

The Rotec Radial has the desirable ability to run in full mechanical mode continuously and does not depend solely on electrical supply. However in an endeavor to complement the mechanical features Rotec Aerosport has incorporated a 35amp 12volt alternator, which continuously supplies the entire electrical system.

The key redundancy features of the electrical system are the backup Hall Effect ignition system, which in conjunction with the self-energized magneto, run all the time. Also the backup electric fuel pump (not supplied), which can be used intermittently as required, or full time in the advent of mechanical fuel pump failure. The engine also comes equipped with a lightweight 12-volt starter motor. The use also of full electrical VDO engine gauges with their corresponding electrical senders (not supplied).

WIRING REQUIREMENTS

The following section covers in depth, the steps required to install electrical sub-systems on your radial engine with a brief description of the components function.

ALTERNATOR

The 12volt alternator is of the modern auto type and incorporates an inbuilt electronic regulator that is designed to maintain a constant 14volts charge. The unit is earthed through the carcase so the engine must have an earth strap grounding it to the negative side of the battery. Very little power is required to run the ignition system. The magneto is self sustaining, generating power using rotational energy created by the engine. Contrary to conventional wisdom, the alternator is not a critical component for engine operation. A failure would be undesirable and inconveniencing, although not detrimental. If the alternator belt or alternator were to fail during operation, the engine would continue to run on the magneto (R2800 only) and electronic ignition for as long as there is fuel available. Instruments relying on power would continue to run off of the battery until it runs out of charge. A charged battery is required to power the starter motor to generate enough RPM to start the engine.

ALTERNATOR WIRING REQUIREMENTS

- The M6 stud is the positive main battery terminal of the alternator (Fig. 32.) and should be connected to the battery via an 80amp fusible link and 5mm battery cable from the cold or switched side of the battery isolator or master switch.

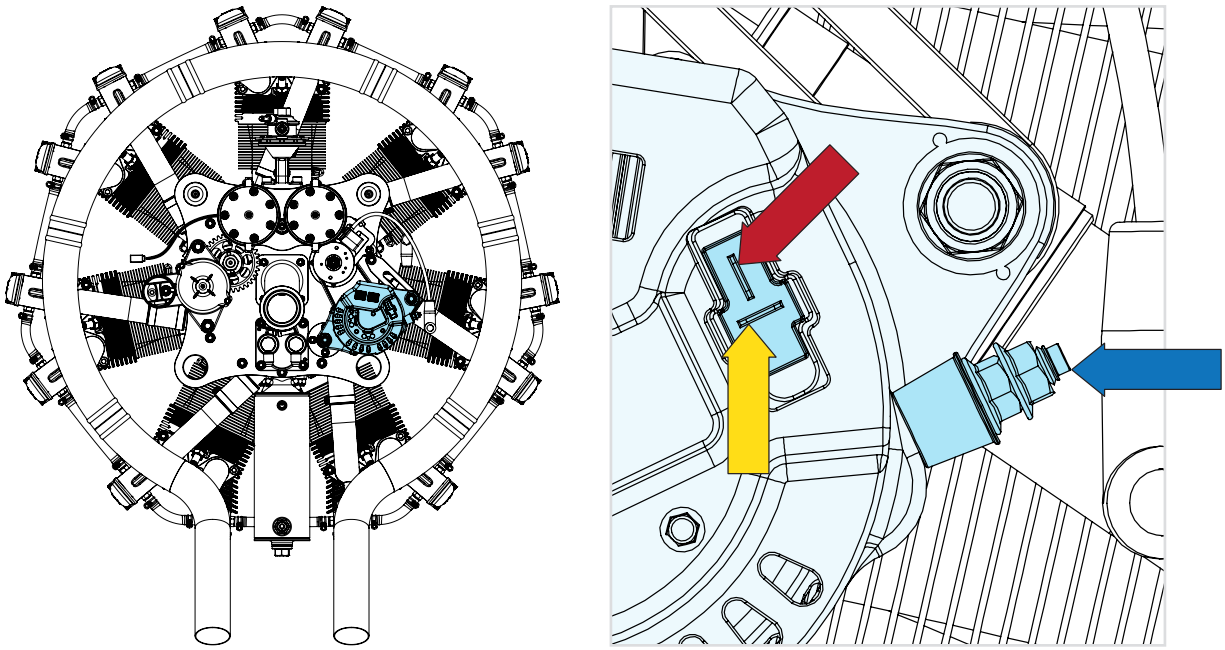
- The “T” plug at the back of the alternator (Fig. 32.) has two male spade terminals, the horizontal one is marked “IG” and should be supplied ignition positive via the ignition switch and 20amp fuse. The vertical terminal is for the warning light and is supplied ignition positive via a small 2-3 watt 12volt warning light which is placed in series between the supply and the alternators vertical terminal on the same “T” plug.

INSPECTION

The alternator (and starter motor) are designed to do several hundred thousand kilometers (or miles) in an automobile before servicing is required. The average aircraft engine flies nowhere near the equivalent hours in automobile. Therefor regular inspection intervals are not required. The only thing you may consider inspecting every 100 hours is:

- The alternator belt for any damage or significant cracks and degradation. The alternator drive belt will be more susceptible to failure with improper installation (see Alternator Drive Belt).

- Ample grease on the starter motor bronze bush in the mount back plate.



(Fig. 32. Red arrow warning light terminal.
Yellow arrow “IG” ignition terminal and Blue arrow 6mm battery terminal).

ALTERNATOR DRIVE BELT

Common installation mistakes found with with R2800 & R3600 alternator drive belt:

- The belt tension being too low. The close center distance between the two pulleys makes the belt tension feel a lot tighter than it really is.
- Misaligned pulley grooves. Shim base mount as required.
- Forgetting to tighten the lower alternator mount as it is somewhat hidden. When this is not tightened, the loose alternator tends to sit on an angle causing belt misalignment.

Contact Rotec for replacement parts.

ELECTRICAL SYSTEMS

STARTER MOTOR

The 12volt starter is also of the automotive type and has an in built solenoid which once energised engages the drive pinion whilst simultaneously connecting battery positive to the motor section and thus cranks the engine.

STARTER MOTOR WIRING REQUIREMENTS

- During operation the starter motor draws a large amount of current from the battery so therefore the main earth strap should be substantial and have a 250 amp capability, the length of the earth cable will determine the diameter of cable required. The main earth cable should be connected directly from the negative battery to the ground base of one of the starter motor mounting nuts. Or alternatively the (steel) airframe may act as the interface between the negative battery terminal and the starter motor. In this case it should be noted that the airframe is no longer isolated or "double insulated" and any battery positive contact will result in a "short" and possible fuse or wiring damage may result.

- The starter motor has only two electrical connections they are both found on the starter solenoid. The large M8 stud is the main positive battery terminal and should be connected to the battery via the battery isolator or master switch, again large battery cable in the order of 250amp is required for good cranking performance. The second terminal on the solenoid is the switch or energise terminal this is a spade terminal and is connected to battery positive on the cold or switched side of the master switch via a normally open spring return starter button switch, 4mm cable for this connection with a current draw of around 20 amps.

WARNING:

TO AVOID HYDRAULIC LOCK, IT IS MOST IMPORTANT THAT IN YOUR WIRING DURING CONSTRUCTION THAT THE STARTER MOTOR IS SEPARATED FROM THE IGNITION/MAG CIRCUIT. PLEASE CHECK THAT THIS IS SO BEFORE STARTING THE ENGINE.

ELECTRICAL IGNITION

Unlike the self-energised magneto, the second ignition system requires external power to operate. It is to be used full time as the alternator keeps everything charged. It is a solid-state unit and does not require adjustment.

ELECTRICAL IGNITION WIRING REQUIREMENTS

- A factory made wiring harness is supplied with the Hall Effect electronic ignition system so wiring is kept to a minimum. The positive (+) terminal of the ignition coil requires a 5mm ignition positive supply this should be supplied via a 25amp ignition switch. At the coil this will be terminated by a 5mm eye terminal placed under the positive side of the coil which it will also share with the factory fitted eye terminal which supplies power to the ignition module (pre wired).

- Connect the pre wired female three pin "Deans" plug to the male three pin "Deans" plug on the left hand distributor cap (rear perspective) Note the groove in the plugs signifying correct alignment.

- The small seven-pin black box ignition module should be mounted to a flat piece of alloy plate with the special heat transfer cream applied to the metallic back of the module. The module should be earthed along with the earth eye terminal protruding back from the supplied ignition harness plug boot.

- The auto style ignition coil should be mounted with the high-tension post vertical. It is for this reason that push on coil terminals are not permitted as they are fighting gravity.

NOTE:

Both the magneto and Electronic ignition timing are factory set prior to shipping.

ELECTRICAL FUEL PUMP

A back up electric fuel pump (not supplied) is recommended to be used in **SERIES** with the supplied full time mechanical pump. The electric pump must not exceed a maximum fuel pressure of **4psi**, or possible carburettor over flow may occur.

ELECTRICAL FUEL PUMP WIRING REQUIREMENTS

- Pump should be mounted to negative earth and supplied ignition switched positive, via 20amp fused axillary fuel pump switch.

ENGINE GAUGES

Engine gauges (Optional Extra) are the VDO 12-volt auto type and are all electrical. Follow manufacturer's wiring specifications.

- Oil pressure 0-5 x 100 Kpa
- Oil temperature 50 - 150 deg C.
- Oil pressure warning light/Engine hour switch
- Engine Hours
- Volts 12v
- Cylinder Head Temperature (CHT)
- Exhaust Gas Temperature (EGT)
- Fuel Pressure
- Tachometer

TACHOMETER

Rotec Aerosport recommends using the standard Rotec Radial Tachometer - VDO Part # 333 035 011. More information can be found in the Appendix #. Other tachometers can be used at the users discretion. Connecting:

CONNECTING:

- Pin 4 and 5 connect to the +12VDC bus
- For a tachometer pulse, connect pin 8 on the tachometer to:
- Wire 7 on the ignition module, which provides a digital signal (square wave).
- The negative side of the coil (-), which provides a pulse signal (sin wave).
- Pin 7 on the tachometer is not used

Pin-out connections can be sourced from any good electronics store.

PROGRAMMING:

Programming of the tachometer is to be completed once the engine is installed on the air frame or test bench.

1. Press and hold a pencil or similar into the key located between terminals 2 & 3 on the rear face of the unit
2. Turn on the power
3. The display window will show either "select", "pulse" or "adjust". Release the button when "pulse" is displayed.
4. After approximately 3 seconds, "P14.5" or similar will appear and the digits will flash consecutively starting with the last digit. Quickly enter by pressing down on the key button, then:
   R2800 – 3.5 pulses per revolution
   R3600 – 4.5 pulses per revolution

NOTE:

For example on the R2800, enter 5 then move to the next flashing point area and select 3. This will equal 3.5 pulses per revolution.

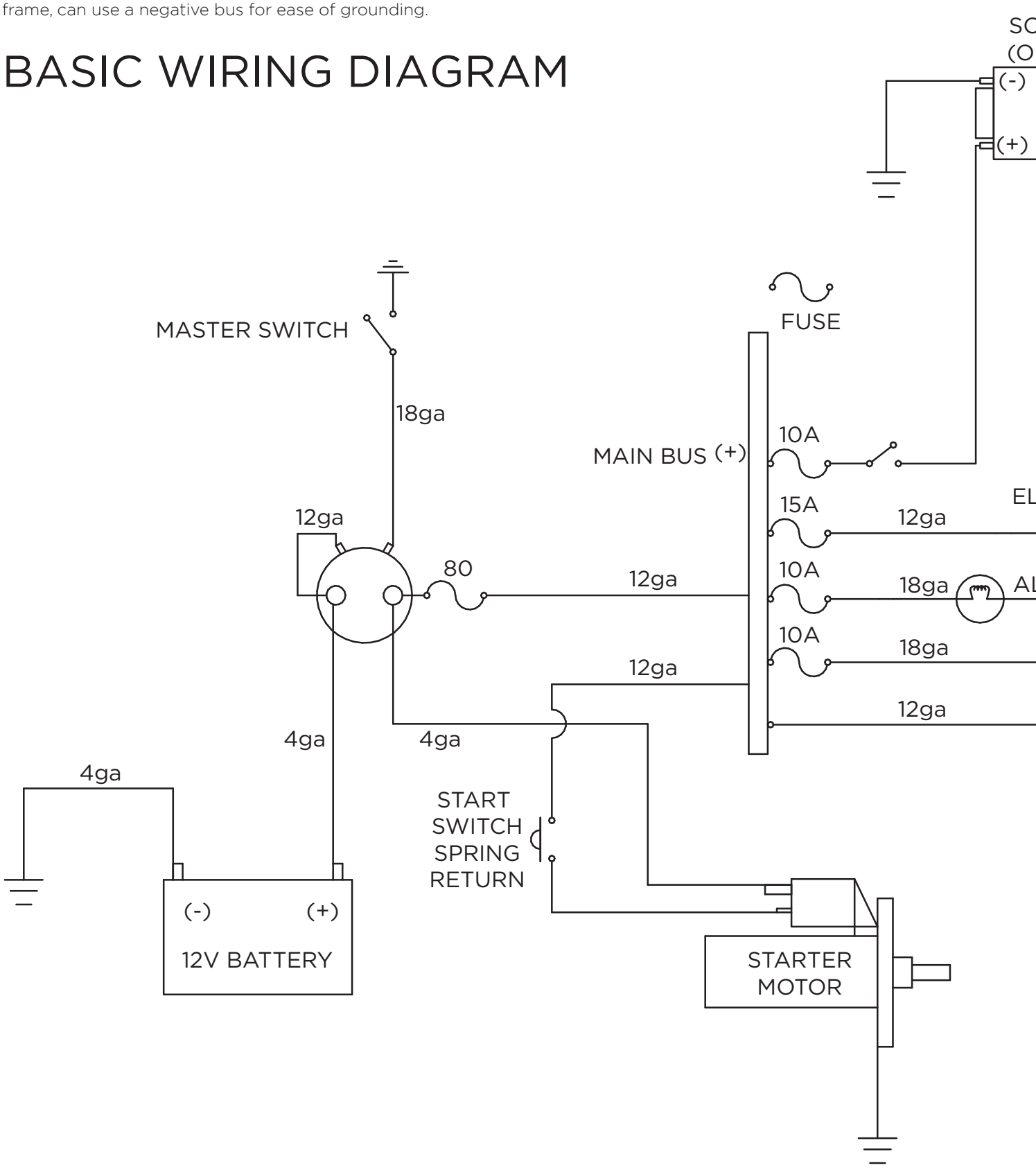
5. The display will then change over to the "operating time hours" indicating that you have completed the procedure for setting up the unit

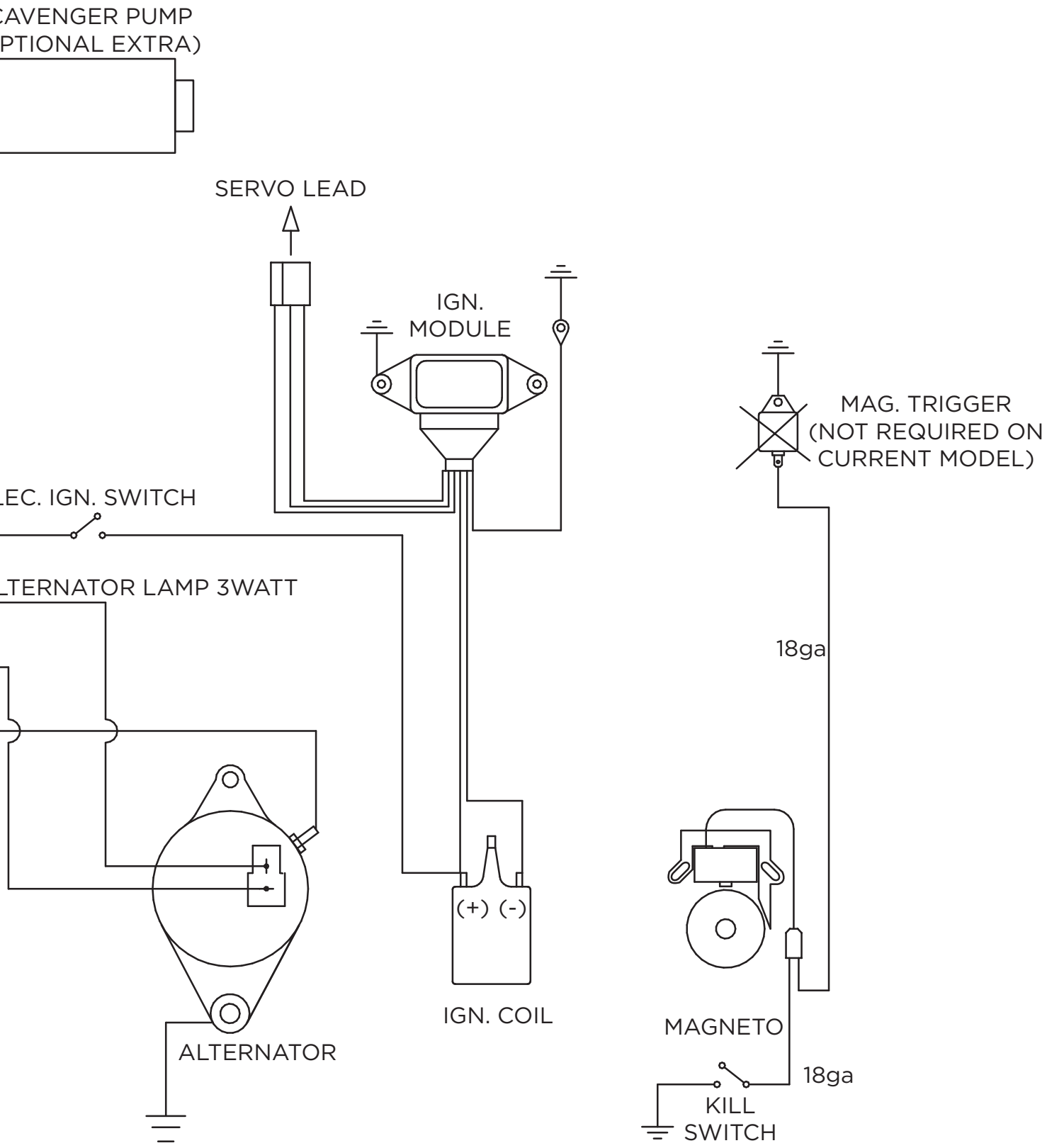
ELECTRICAL SYSTEMS

GROUNDING ELECTRONICS

Electrical components can be grounded to anything connected to the negative side of the battery. Aircraft using a metal air frame can ground components to the chassis much like a car. Aircraft using a composite or wooden air frame, can use a negative bus for ease of grounding.

BASIC WIRING DIAGRAM




CAVENGER PUMP
PTIONAL EXTRA)
SERVO LEAD
IGN.
MODULE
MAG. TRIGGER
(NOT REQUIRED ON
CURRENT MODEL)
LEC. IGN. SWITCH
LTERNATOR LAMP 3WATT
18ga
(+) (-)
IGN. COIL
MAGNETO
18ga
KILL
SWITCH
ALTERNATOR

FUEL SYSTEM

GENERAL

The fuel system comprises of two fuel pumps one mechanical (supplied) and one electrical (not supplied). They are both plumbed in series and should supply fuel via a good quality in-line fuel filter, at a pressure not exceeding **4psi.**

FUEL METERING

Options available for fuel metering include:

- The Rotec TBI Fuel System, which is highly recommended as it offers superior performance, in flight mixture control, is fully aerobatic and is less suitable to carburettor ice compared to other carburettors.
- The Bing Carburettor is offered as standard. Carburettor heat is recommended on this device as it is more susceptible to carburettor icing than the Rotec TBI Fuel System.

We have not seen any attempts to convert the engine to electronic fuel injection at this time

ROTEC TBI-MK.II ADJUSTMENT

Open the mixture screw 1-2 turns, fine adjust for smooth idle. The determination of the main jet is factory set at full power, full load, with and EGT (Exhaust Gas Temperature) reading of 600 +/- 20 degrees C.

NOTE:
For detailed information regarding operation and adjustment of your Rotec TBI-Mk.II, please read the product manual that came with your purchase.

BING CARBURETTOR OPERATION

The carburettor is a 40mm type 94 Bing and features automatic pressure compensating mixture control. There is no manual mixture control. The carburettor is factory set on the test run by Rotec and should only require minor adjustments. The carburettor is supplied as standard from Bing with stock control levers. The levers and butterfly return spring may require modifications to suit. Thorough inspection for correct carburettor lever operation for both the choke and throttle butterfly should be employed before first flight.

An air filter and carburettor heat (both not supplied) should be incorporated in the air intake ducting.

The choke should only be employed for starting purposes only and must NOT be used as enrichment devise during cruise operation.

As a part of the engine test run all carburettors are adjusted for best operation. However due to different propellers and applications minor adjustments may be needed to the idle dead stop which is a screw that controls the amount of “Butterfly Crack” required for a smooth Idle. Also the shrouded brass idle mixture screw situated vertical facing down. This screw controls idle mixture volume and should be adjusted in conjunction with the previously mentioned dead stop.

The main jets are factory set and control fuel mixture at higher power settings. They should not be tampered without first consultation a Rotec technician. A too lean mixture due to the installation of incorrect jet specifications can lead to high combustion temperatures resulting in possible engine damage.

For all servicing / repairs / Spare parts for the Bing Type 94 Carburettor please consult an authorised Bing service centre. Or alternatively a Rotec technician.

WARNING:
The factory supplied Bing carburettor cannot supply fuel when inverted or subjected to negative gravity. Engine failure due to fuel starvation may result.

IMPORTANT:
Check all carburettor couplings, both fluid and mechanical, are integral and secure. Throttle butterfly should spring return to FULL power or open and choke should spring return to OFF or lean.

MAGNETO IGNITION SET-UP

As mentioned earlier the R 2800 utilises two full time independent ignition systems. One of these the magneto has the desirable feature of self-energized operation. The system only has one moving part, the rotor. The stationary coil (stator) is collapsed by a modern type trigger unit, it is solid state and supersedes the old points system.

A single wire extends from the magneto coil (stator) and is terminated with a twin terminal female bullet connector. One side of this terminal is connected to an earth common kill switch. The magneto is considered HOT when the switch contacts are open, and OFF or COLD when closed and switched to earth. The other side of the twin female terminal from the coil is connected directly to the small trigger unit which must be mounted to earth via the eye lug of its case.

NOTE:

The magneto timing is factory set and should not require adjustment.

FUEL TYPES

Rotec Aerosport have tested a variety of petrol grades and recommend the use of all types of aviation gas (Petrol) including Shell 100LL or better. AVGAS has proven to be cleaner burning with less spark plug deposits. High-octane premium unleaded or leaded auto fuel is permissible where AVGAS is unavailable; however in these cases, carburettor adjustments may be necessary.

AVGAS 100LL is the recommended fuel for all Rotec radial engines.

NOTE:

Unleaded fuels are not recommended for Rotec radial engine as “flying” fuels (i.e. 100% power use) due to their low resistance to detonation and valve lubrication. We advise customers who intend to use unleaded fuels to first consult with Rotec. Carburettor and ignition timing may need alteration.

WARNING:

Octane ratings for car fuels and aviation fuels are not the same, i.e. 98 Octane RON automotive fuel is far lower than 100 Octane “MON” AVGAS.

100 MON AVGAS LL = 85 RON Premium Automotive Fuel

FUEL & ADDITIVES

NOTE:

Only technical information released by Rotec Aerosport should be considered correct. Many third party opinions found on the Internet are inaccurate.

RECOMMENDED FUEL:

The fuel of choice for the Rotec R2800 and R3600 is AVGAS. The compression ratio of the R2800 and R3600 is 8.5:1.

All engines built before late 2005 ("B" specification) should restrict fuel type to AVGAS until ignition timing is reduced to 22 degrees to meet later model engines.

All engines supplied beyond late 2005 (Classified as "C" specification or above), will function on Premium unleaded fuels (95 RON or higher). C spec engines have the ignition timing set to 22 degrees to avoid any uncontrolled detonation. When using Premium Unleaded fuels (95 RON or higher), usage should be interrupted from time to time with the one or more tanks of AVGAS. AVGAS can be added to any remaining unleaded fuel in the tank, as there is no need to flush the unleaded fuel out of the system.

When using premium unleaded, it is wise to install a knock sensor to detect instances of uncontrolled detonation along with a close examination of the spark plugs looking for carbon build up; including a regular valve and valve seat examination looking for burning.

RECOMMENDED FUEL ADDITIVE:

Rotec Aerosport have tested and recommend Flash Lubes Valve Saver. It has been found to be beneficial in reducing the harshness of unleaded fuels. The product was found to be compatible with Premium Unleaded, AVGAS and in any mixture of these fuels. When using Valve Saver, flushing out fuels when switching from one to the other is not required.

Apart from less carbon on the heads and pistons, and less wear on the valves and seats; Flash Lubes Valve Saver also cleans the engines fuel delivery system.

Please check via the Internet for availability of Flash Lubes Valve Saver. http://www.flashlube.com/

NOTE:

Care should be taken to ensure that any additives used are compatible with AVGAS, Premium unleaded or in any mixture of the two.

WARNING:

Continued use of Premium Unleaded on pre "B" specification engines, without the use of additives, will cause piston rings to crack, as well as valves and valve seats wear more rapidly than expected.

All unmodified engines supplied prior to "B" specification (prior to late 2005), contact us on how to retard the engine timing to 22 degrees.

If you are unsure of your engine specification please contact us. Quote your engine serial number and date of purchase if possible.

FUEL SUPPLY

Recommended Minimum Line Size - 1/4" (6.35mm)

MECHANICAL PUMP:

Location - Mounted on the distributor assembly, top rear of the engine.
Capability:

- Able to draw fuel from a static pressure fuel tank
- Will not allow back flow

ELECTRICAL BOOSTER PUMP:

Status - Mandatory. In the unlikely event of the mechanical fuel pump failing, used as a redundancy.
Secondary Function - Priming is possible when the engine is not running.

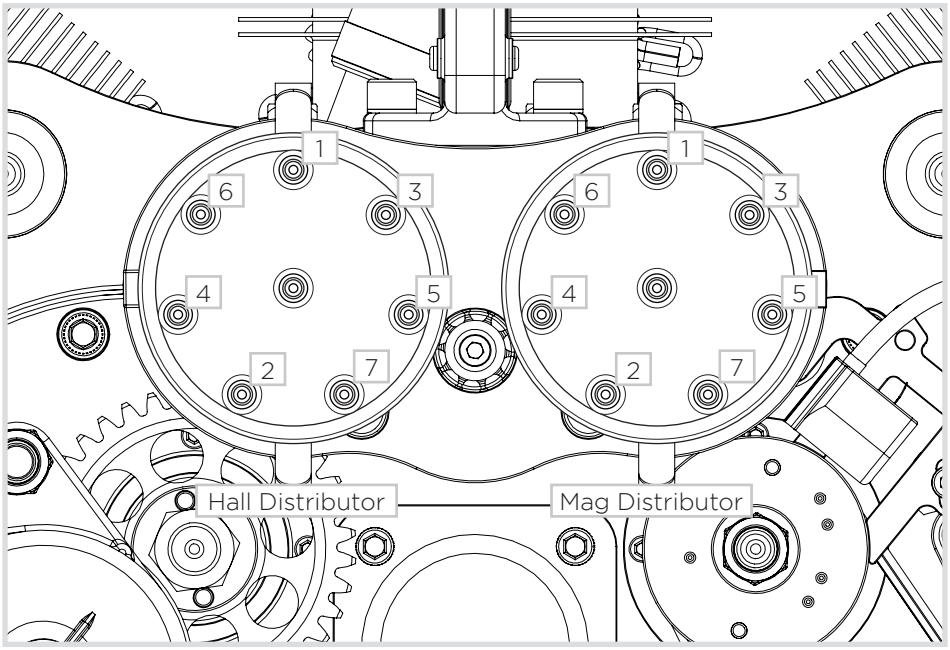
Configurations:

Configuration Option	Advantages	Requirements	Disadvantages
Series	Simple fuel circuit	• Rotec TBI Fuel System or • Regulator Bing Carburettor*	• Forgetting to turn on the electric fuel pump, the mechanical will draw fuel through it. The engine will run, although it could starve at WOT. • Will overflow the Bing Carburettor, as in most cases fuel pressure will be too high.
Parallel	• Better redundancy, as if the mechanical pump were to rupture, fuel supply will continue. • Can be used with the Bing Carburettor	• Electrical pump requires a check valve to prevent back flow. Typical cylindrical style facet fuel pumps will not allow back flow.	• More fuel lines required.
NOTE: Fuel pressure supplying the Bing Carburettor should not exceed 4 psi. If it does, a fuel regulator must be used. Engines using the Rotec TBI Fuel System have greater fuel pressure tolerance.			

IGNITION LEADS & FIRING ORDER

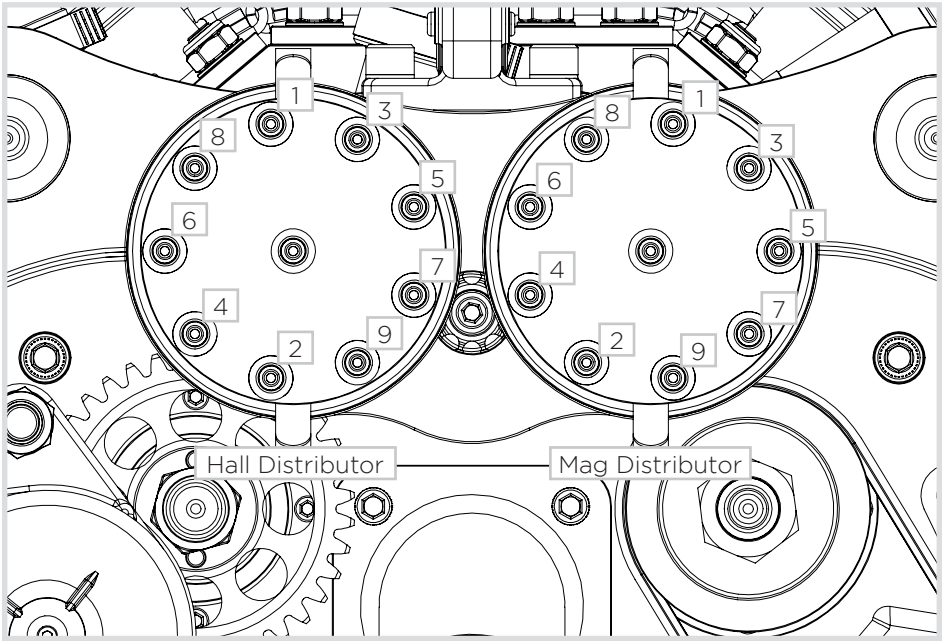
Both distributors simultaneously distribute spark to the correct cylinder via high performance ignition leads. Standing in front of the engine the cylinder count is in a counter clock wise sequence starting with the top cylinder being number 1 then to its immediate left 2 then 3, 4, etc. finishing with number seven cylinder just to the right of the top cylinder (number one) for the R2800 and number nine cylinder for the R3600. From this same front view the firing order is every alternate cylinder, i.e. 1, 3, 5, 7, 2, 4, 6 etc. (see fig 33 & 34.). Both rotor buttons revolve clock wise (rear perspective).

R2800 DESIGNATION



(Fig 33. Distributor caps and ignition lead positions in correct firing order)

R3600 DESIGNATION



(Fig #. Distributor caps and ignition lead positions in correct firing order)

ENGINE OPERATING PROCEDURE

WARNING: HYDRAULIC LOCK

NOTE

Rotec Aerosport requires strict adherence to the pre-flight and post-flight procedures contained within this manual to avoid the phenomenon known as “Hydraulic Lock”. It is easy to damage an engine if these measures are not followed. Any engine damage sustained by Hydraulic lock is not covered by warranty as it is easily avoided by following theses operational guidelines.

Hydraulic lock on radial engines occurs most commonly post flight. After shutdown, hot oil weeps past the piston rings and fills the combustion chamber(s) and or intake pipes with oil. If this accumulation of oil is not removed from the combustion camber(s) prior to the next start then as the piston approaches TDC (top dead centre) it will attempt to compress the accumulated oil. As oil is a liquid and liquids cannot be compressed, any further attempt to complete the cycle results in redistributing the immense forces back through the connecting rod causing it to buckle and or bend.

WARNING

Once the connecting rod is bent, it cannot be straightened and it must be replaced. To replace a damaged connecting rod, a full engine overhaul is required.

HYDRAULIC LOCK SYMPTOMS

A bent rod would prevent the piston’s movement up and down the bore in a straight line; consequently the piston would be cocked over and rubbing on the cylinders side walls resulting in an increased friction and wear.

Typical symptoms:

- Smokey Cylinder(s)
- Loss of Power
- Excessive Heat on the Cylinder
- Roughness in Idle
- Roughness in Running
- Loss of compression on the cylinder in question (the lowering in the compression is attributed to a shortened piston deck height resultant from the bend in the rod)
- Fowling of the spark plug (when compared against other plugs)

Further flight should cease if you experience one or more of these symptoms until the cause can be accounted for.

NOTE

If you believe you have suffered Hydraulic Lock, contact Rotec Aerosport to seek technical advice and or rectification strategies.

FLYING WITH A BENT ROD

If the deformation is slight, the engine may start and run seemingly without problem. In general, providing all remaining cylinders function correctly, there is sufficient power generated for flight.

The real danger of not detecting a bent rod occurs when the distorted or bent rod snaps through the continuous flexing caused by the misalignment of the piston with the bore and the reciprocating action of the engine. Once the rod snaps, the engine’s main power station suffers further internal damage. If this happens in flight, immediate emergency landing is required.

CYLINDERS MOST SUBJECT TO HYDRAULIC LOCK

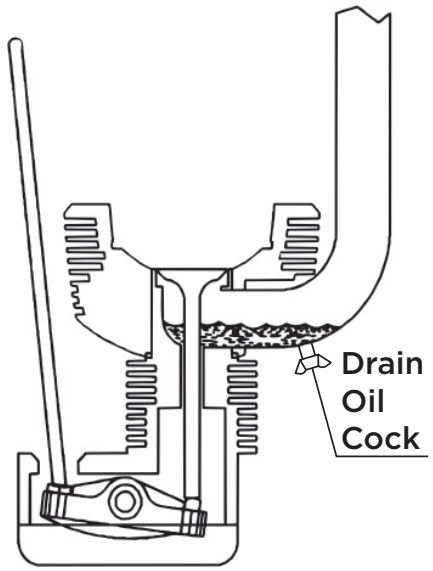


Fig #. Accumulation of oil in the intake pipe of the 2 lower cylinders

All cylinders can experience hydraulic lock but the most likely are the lowest two, namely: cylinder #4 & #5 on the R2800 and cylinder #5 & #6 on the R3600. Out of the two cylinders, R2800's cylinder #4 and R3600 cylinder #5 are the most likely to experience a lock due to the relative position of the intake pipe and the mechanics of the engine.

Example Situation:

If on shutdown, the intake valve is partly open and the exhaust valve fully closed on cylinder #4, then any oil that penetrates into the combustion chamber will flow through the open inlet valve and fill up the intake pipe. On restart, this stored oil is sucked into the engine resulting in a hydraulic lock.

This accumulation of oil presents the greatest danger as hand cranking does not detect or remove it. Nor will cranking using the starter motor with the ignition off. In both instances the speed of the piston action is not sufficient enough to develop a vacuum strong enough to remove any accumulated oil.

However once the engine is started under power (ignition on) the piston speed does become sufficient to create a vacuum strong enough to suck the oil back into the chamber and cause an instance of hydraulic lock along with associated damage.

KEY POINTS

1. The amount of oil required to do damage is very small. The combustion chamber's volume is only 55cc (on both the R2800 & the R3600). If the amount of oil exceeds 30cc, it is unlikely the engine will survive serious damage.

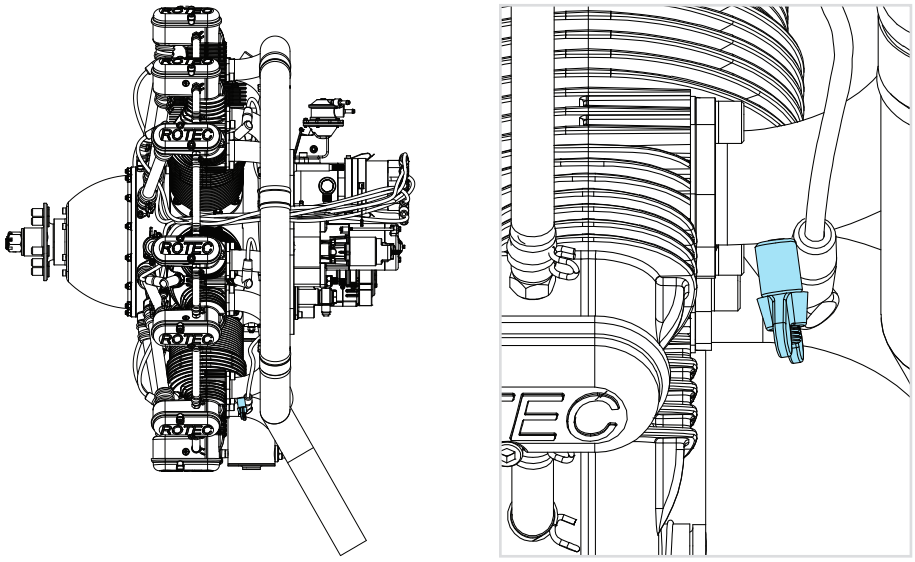
2. Hand cranking cannot remove this oil - the speed of the cranking process is not fast enough to create a vacuum of sufficient strength to suck the oil back into the chamber.

3. Using the starter motor with ignition off does not remove this oil. Like hand cranking the speed is not high enough to move the oil.

4. Once the engine is started, the speed is high enough to suck the oil back into the chamber.

5. **It is imperative that the fitted drain cocks be employed.**

INTAKE PIPE DRAIN COCKS



(Fig #. R2800 Drain Cocks example)

ENGINE OPERATING PROCEDURE

HYDRAULIC LOCK QUICK CHECKLIST

PREVENTION:

1. The starter motor must be wired separately from the ignition switch. Otherwise the starter cannot be used for checking.

2. After the engine has run, open the intake drains to allow any oil to drain. If the engine is not running, the intake drains should always be open. Intake drain locations:
   Rotec R2800 – 2 lowest intake pipes
   Rotec R3600 – 3 lowest intake pipes

3. Do not switch the ignition on until the starter has cranked for at least five seconds. The starter is relatively weak and will stall if it encounters significant oil in the cylinders when starting.

4. Before each flight, perform the checking procedure. Even for brief stops.

CHECKING:

1. Check the intake drains were left open from a previous engine start*
   A.) If they were left shut, open them and allow any oil to drain completely before proceeding. No drips at all must be observed. If necessary remove the drain cocks completely.

2. Hand prop the engine with the intake drains open*
   A.) If you detect a lock carefully reverse the rotation of the prop several turns backward
   B.) Try normal hand propping again
   C.) If the lock persists, remove the lower spark plugs and let the oil drain whilst slowly turning the prop. Once the oil stops flowing return the spark plugs.

3. Close the intake drains

4. Double check the ignition is off

5. Use the starter motor to turn the engine over for 5 seconds
   A.) If the engine does not turn over when using the starter only, then hydraulic lock is still present. Repeat step 2.

6. If the starter turns the engine over for 5 seconds, the engine is checked for starting

NOTE:
If you forget to close the intake drains and go flying, the mixture will be affected but no damage will result.

NOTE:
Hand propping engines with minimal running time can be restrictive. This is not to be confused with hydraulic lock. However, users need to experience the difference so that both can be recognised.

INITIAL ENGINE START PROCEDURE

WARNING:

This process is purely for the first engine run. Once you have finished installing your radial engine and have conducted the test run, follow the "Normal Engine Start" procedure.

- Check propeller is in good condition fits neat on drive lugs and is properly secured via six lock wired M8 high tensile bolts.
- Inspect engine mounting points, and engine frame to air frame coupling.
- Check oil level in tank, allow for an extra three litres which will be immediately absorbed by a dry engine with empty scavenge sump and oil lines.
- Fill oil filter full of oil.
- Try and prime as many oil lines as possible as this will reduce the time it takes to gain good oil pressure.
- Disconnect the final oil pressure "IN" line positioned between cylinder bases #5 and #6. Use an old plastic ketchup bottle full of oil, the tapered end is good for sealing against the fitting, and push oil into engine by squeezing hard, this will give the main crank pin and master rod bearing a good covering of oil prior to cranking. With the hose still off use the same bottle to push oil back up the hose just prior to re-connecting the oil line.
- Check that all oil lines and fuel connections, carburettor linkages and all electrical are connected and that there are no loose fittings.
- Switch master OFF (take out key!) switch both ignition sources and fuel OFF.
- CLOSE throttle shut.
- By hand pull propeller through four (4) complete revolutions. This is to check for oil in the lower cylinders which if present can cause a hydraulic lock. Liquids cannot be compressed, steel conrods can!!! If this occurs remove lower spark plugs and drain out trapped oil and start hydraulic procedure over.
- Switch master ON, but leave all spark and fuel sources OFF. Crank engine by starter motor for a few seconds to confirm no hydraulic lock.
- Switch on power to gauges and oil warning light. Leave both spark & fuel sources OFF. Remove one spark plug from each cylinder. Crank engine by starter motor in short bursts of no more than 10 seconds at a time until oil light goes out.
- Leave throttle closed, push choke ON full rich. Replace all spark plugs and leads turn on electric fuel pump to prime fuel lines. Check no fuel leaks.
- Switch both spark sources ON crank engine by starter motor until engine starts, look for oil pressure light OUT followed by oil gauge rise. Run no longer than 15 seconds at idle with oil warning light ON! If still no oil pressure re-prime and start over.
- Bring revs up to high idle. Pull choke OFF. Increase revs slowly.
- Run for a few minutes Shut down and top up oil absorbed by dry engine.
- Employ hydraulic lock check procedure, and restart engine.
- When oil temp comes into green or above 30 C, full power permissible.
- It is not recommended to exceed 3700 crankshaft rpm.

WARNING:

Subsequent restarts should not require oil priming.
Hydraulic lock procedure must be employed prior to ALL starts.
Hydraulic lock is more prevalent with a hot engine due to lower oil viscosity.

ENGINE OPERATING PROCEDURE

AVOIDING HYDRAULIC LOCK

WARNING!

Hydraulic Lock procedure must be employed prior to ALL starts. Hydraulic lock is more prevalent with a hot engine due to lower oil viscosity.

To avoid costly Hydraulic Lock on the radial engine, the following procedures have been developed to ensure the optimal start and shutdown are attained. A bent rod will lead to catastrophic failure in a matter of hours. To prevent that, follow the Best Practice Start & Shutdown Procedure.

BEST PRACTICE START PROCEDURE

1. Check the drain cocks were left open from a previous engine start. If they were left shut then open them now and allow the oil to drain out COMPLETELY before proceeding. No drips at all must be observed. If necessary, remove the drain cocks completely.
2. Remove the inner most spark plug from the lower cylinders: (4 & 5 for R2800, 4, 5, 6 & 7 for R3600) and insert foam dust plugs. If already off, then ensure the dust plugs are in place.
3. Open the intake drains (cylinder 4 & 5 for R2800, 4, 5, 6 & 7 for the R3600) and remove their dust plugs (or oil collecting can if used instead).
4. REMOVE LOWER CYLINDER INNERMOST SPARK PLUGS (cylinder 4 & 5 for R2800, 4, 5, 6 & 7 for R3600)
5. Rotate engine by hand 8 blades.
6. Engage electric starter for a few seconds.
7. Clean up mess (if any).
8. Replace spark plugs and store dust plugs in a safe place.
9. Close intake drains once oil has stopped dripping.
10. Engage electric starter motor.
11. Switch ignition on/Magnetos on.
12. Start engine.

BEST PRACTICE ENGINE SHUTDOWN PROCEDURE

All radial engines by nature, when static or allowed to idle at very low rpm's for an extended period of time, tend to accumulate excess oil in any area below the horizontal centre line of the engine's crank case. This is not a concern during normal operation as oil is being slung around violently by the internal works of the engine, leaving the scavenge drain ports as the only available exits for the oil. The following procedures will minimise that collection. This will help reduce the chance of Hydraulic Lock (HL). HL can lead to catastrophic engine failure.

1. Just prior to shutdown, it is recommended to run the engine for a short period at 50% power or around 2000 RPM. This allows the scavenge pump to suck out the excess oil from the engine and thus minimising the amount of oil left trapped in the engine after shutdown.
2. Switches – OFF (all electrical except ignition).
3. Throttle – Idle.
4. Ignition switches OFF.
5. Auxiliary Electric Oil Scavenge Pump (optional equipment) – ON for 10-15 seconds, then OFF.
6. Master Switch – OFF
7. Intake Drain Cocks – OPEN. After the conclusion of each flight, open the drain cocks and allow any oil to drain.
8. Open ALL intake drains (use rag if hot) and install dust plug (or oil collecting can).
9. Remove one spark plug from lower cylinders (4 & 5 for R2800, 4, 5, 6 & 7 for R3600)
10. Place Warning Ribbons to indicate drains are open.
11. Hang spark plugs on clip and place on top of keys on fuel tap lever.

On subsequent re starts the less oil in the engine the better as the chance of hydraulic lock is greatly reduced.

Extended periods of Idling should be avoided as oil will not only build up in the crank case but also the risk of cylinder glazing is increased due to reduced piston ring pressure.

STARTING: ROTEC TBI FUEL SYSTEM

CONVENTIONAL STARTING:

1. Hydraulic Lock check
2. Turn on fuel pump
3. Set mixture to Full Rich
4. Set Throttle to WOT
5. Depress the regulator override for 5 seconds, priming the intake with fuel*
6. Set throttle to closed
7. Announce “Clear Prop!”
8. Turn on ignition
9. Engage starter motor
10. Engine Starts
    - If engine does not start, hold the regulator primer button while activating the starter motor
    - Once the engine has been started, subsequent restarts should not require priming up to several hours later

NOTE:

Inadequate amounts of fuel will be released if the throttle is closed during priming, as the fuel jets on the spray bar are covered by the throttle slide. Therefore, use WOT when priming.

HAND STARTING:

1. Follow steps 1 - 6 for conventional starting
2. Ensure ignition system is off*
3. Slowly hand prop the engine so that fuel vapour is sucked into the engines combustion chambers
4. Position the propeller so that it is ready to be hand propped for starting
5. Turn on ignition
6. Standing in front of engine, throw the propeller from the top to bottom CCW whilst stepping back in caution
7. Engine starts

NOTE:

If the ignition system is turned on and then hand propped after priming, the engine could fire throwing the propeller backwards endangering the user.

ENGINE OPERATING PROCEDURE

SUMMARY

Hydraulic lock can result when oil is present in the cylinder. Oil is practically incompressible in an engine cylinder and will prevent the engine from rotating. If the ignition is on and the engine is started, enough force can be applied to the piston to bend the conrods. The starter motor alone will no be powerful enough to damage the engine if there is hydraulic lock. The starter motor will simply be stalled.

Each shutdown may position the intake valves allow oil to seep past and into the intake pipe. This accumulated oil, unless removed, can be sucked back into the combustion chamber resulting in hydraulic lock.

Engines using an auxiliary oil scavenger pump must still perform the hydraulic lock checking procedure. The pump cannot drain absolutely all oil from the engine.

The fact that the Rotec Radial starts easily and runs so smoothly can lead to complacency. Do not allow complacency creep into your start up and shut down procedures. Its important that you memorize the prevention and checking procedure and understand the reasoning behind them.

ADVERSE OPERATING CONDITIONS

WINTER OPERATION

It is recommended to service the engine prior to the cold season. Oil selection should be a consideration and viscosity change may be necessary in extreme conditions of cold. Consultation with aviation oil supplier is recommended.

CARBURETTOR ICING

It is important to distinguish between two kinds of icing:

- Icing due to water present in fuel.
- Icing due to high air humidity.

WATER IN FUEL

Water in fuel will tend to accumulate in the lower portion of the fuel system and can lead to freezing of fuel lines and associated hard ware. Remedies are:

- Drain fuel tank via fuel tank water drain.
- Use water separator or filter when fuelling in high moisture conditions.
- Install a generously sized water separator.
- Prevent condensation of humidity, i.e. avoid temperature difference between aircraft and fuel.

CARBURETTOR ICING

Carburettor Icing may occur in the venturi of the carburettor. Left unchecked, it can lead to failure of the fuel system. Rectifying this engine debilitating condition requires directing preheated air though the carburettor intake to melt ice away.

Slightly reduced performance is expected anytime during carburettor hear use. This includes normal operations. With carburettor ice, carburettor heat operation may first cause the engine to lose noticeable power and run rough. It should then smooth out and regain power as the ice clears.

Procedure:

- Carb Heat – ON. Leave on until engine is running smoothly. Change altitudes, or perform other weather appropriate procedures as recommended until you are out of icing conditions
- Carb Heat – OFF.

Use of carburettor heat is recommended as part of normal landing procedures. If a go around is necessary, first insure you have a positive rate of climb and flight conditions allow before turning the carburettor heat off. Carb heat is not needed for normal take-offs.

PERIODIC CHECKS

DAILY CHECKS

- Ensure free movement of throttle and choke levers.
- Check oil level of main oil tank. Oil level should be within the upper and lower limits of the oil tank and must never operate below three litres of oil, a recommended maximum oil level of 6ltrs or greater is recommended. On start up allow for a fall in oil level of around 2 litres prior to the scavenge pump effectiveness.
- Check security of spark plugs, ignition leads and all electrical wiring and connections.
- Check both the fuel and lubrication systems for fluid leaks.
- With both spark plugs removed from cylinders 4 and 5 rotate engine by hand and observe engine "feel". There should be no strange noises and the engine free to turn by hand with the absence of hydraulic lock.

WARNING!

A hot engine may fire even with both ignition off. Always clasp propeller firmly and be prepared.

CAUTION

Continued operation with incorrectly adjusted tappets or valve clearance can result in damage to all or part there of the engines valve train.

25 HOUR CHECKS

- Remove cowlings where applicable and check engine mounts and engine mount rubbers for looseness or deterioration.
- Remove nose and visually inspect PSRU condition (see PSRU).
- Check for missing or loose bolts nuts clamps and pins.
- Check all accessories, intake and exhaust manifolds for loose bolts or hose clamps.
- Check carburettor mount, and linkages for security and ease of movement.
- Check engine wiring harness for frayed or damage loom and is secured and clear of all mechanical movement.
- Inspect condition of alternator fan belt.
- **Drain oil from both the scavenge sump and the main oil tank.**
- **Replace main oil filter.**
- **Replace in line scavenge filter.**
- Check for oil and fuel hose leaks and abrasions.
- Check security of exhaust and intake manifolds.
- Run engine, check at normal temperatures for oil and fuel leaks, check for consistent idle and smooth transition to full power note all pressures and temperatures. Engine stop.
- **INSPECT PSRU (see next heading).**

IMPORTANT:

Users should STRICTLY change oil and BOTH (2) filters every 25 hours. This will keep the engine clean, free of corrosion, avoid gallery blockages and keep oil lubricity effective.

PSRU INSPECTION

Rotec Aerosport instructs all owners to schedule a PSRU/Nose inspection every 25 hours of engine operation. Failure to regularly change the oil and both filters can lead to gallery blockages causing oil starvation to the planet gear bushings.

TO INSPECT PSRU INTERIOR:

1. Remove all 14 x M6 Nylok nuts and washers.
2. Apply pulling force to prop flange, slide hammer etc. Complete nose section should detach from front crankcase.
3. Inspect general well being of all interiors. Observing gear teeth condition and appearance. Pay particular attention to the planet gears themselves, look out for anomalies such as gear damage or any discoloration caused from oil deprivation.
4. Check condition of perimeter sealing 'O'-ring, replace if needed.
5. Clean all sealing surfaces.
6. Make sure nose interior is VERY clean and NO debris is present in crank shaft prop shaft hollows. Oil pressure flows via these hollows to feed oil to the planet gear bushings.
7. Refit nose with 'T' mark to the top.
8. Tighten all 14 x M6 Nylok nuts to 90" (INCH) pounds of torque MAX.

50 HOUR CHECKS

- **Drain oil from both the scavenge sump and the main oil tank.**
- **INSPECT PSRU (see previous heading).**
- **Replace main oil filter.**
- **Replace in line scavenge filter.**
- Remove rocker covers and Adjust tappet clearances both 0.01mm
- Conduct all checks and procedures in 25 hourly check.

100 HOUR CHECKS

- Inspect spark plugs and spark leads, replace if necessary. Do not sandblast or wire brush spark plug threads or galling of cylinder head plug threads may result. To clean plugs use soft nylon brush and solvent. Prior to installation use loctite "Nickel anti seize" on threads.
- **Drain oil from both the scavenge sump and the main oil tank.**
- **INSPECT PSRU (see previous heading).**
- **Replace main oil filter.**
- **Replace in line scavenge filter.**
- Inspect and replace if necessary the alternators fan belt. Magneto coil must be removed to access belt reset coil / rotor clearance using .010" (.25mm) shim.
- Conduct all checks and procedures in 25 hourly check.

2000 HOUR TBO

- At present all overhaul work to be carried out by Rotec Aerosport Australia Pty Ltd. Or by a Rotec approved service man (to be advised).
- Where necessary, changes to the TBO limit or service schedule will be announced by Rotec Aerosport Australia.
- All engine logs and documentation should be included and sent along with complete engine and accessories for total overhaul and evaluation.

PROPELLER STRIKE

Overhaul is required on engines involved in a propeller strike at any RPM, including idle. Full engine tear down allows for the inspection of all drive train parts that could have been affected by the significant loads applied to them, particularly teeth. If necessary, gears will be crack tested and any parts suspected to be at risk will be replaced.

BY ROTEC AEROSPORT

It is certainly possible for anyone mechanically experienced to attempt an overhaul of a Rotec Radial. However, with the enormous level of experience and the countless specialised techniques , it is far safer and faster for Rotec to perform your engine overhaul for you.

At our facilities, it generally takes six separate engine assemblies before a new mechanic no longer requires assistance from an experience technician. After about one year of full time assembly, we see our technicians become highly skilled, knowing our detailed specialised techniques.

Building a single engine can be risky. Some mistakes on overhauls outside our facility have been concerning. There are a host of potential fitting errors and not to mention oil leaks at the very least. Save time and hassle of doing it yourself.

Price:
Instead of purchasing replacement overhaul parts, then potentially causing more harm than good by installing them, contact us for a quotation on overhaul. An overhaul on average, cost less than a quarter of what the original engine cost, to return it to as new quality.

Procedure:
If an overhaul for servicing or a repair after an engine failure is required, contact us and prepare your engine for shipping.

If failure has occurred, it is best not to dismantle the engine in any way. No matter what the cause or who is at fault, we must make a thorough assessment and document accordingly. This is for absolute certainty of the causation, so that the correct repairs, improvements and recommendations are made.

DO IT YOURSELF

If a user opts to conduct overhaul themselves, a disclaimer must be signed as a prerequisite to receiving:
1. Instructional advice (support is limited)
2. Replacement Overhaul Parts

This will note a user's details and product serial number, irrespective of the circumstances. Signing of the disclaimer recognises that the engine has not been appropriately inspected or repaired and could be at risk. For more details, contact us at Technical@RotecAerosport.com.

WARNING:
Overhaul or modification conducted by entires unrecognised by Rotec are not covered by warranty.

Owners of engines approaching TBO or purchases of pre-owned engines often request to conduct overhaul themselves to reduce expenditure. We understand this and as a result offer overhaul at under a quarter the cost of a brand new engine. The disclaimer procedure has been implemented to protect the reputation of our engine so that we can continue to support it in the future.

DETAILS

When overhauled by Rotec, once received, can take 3 to 4 weeks. There may be delays depending on circumstance.

Procedure:
- Full engine tear down
- Inspection of all parts
- Replacement of necessary parts, including:
- Degraded Parts - Rubber and Gaskets
- Serviceable Parts - Oil Filter, Alternator Belt and Oil seals
- Technically Obsolete Parts (designs improved to extend reliability, Rotec is always improving)
- Cosmetically Obsolete Parts - Not replaced, provided they are functioning correctly.
- If applicable, reconditioning of the Rotec TBI Fuel System
- Engine Testing

Warranty: Beginning from first start up, 12-months or 200-hours, whichever comes first.

Engine Hours: Overhaul to 0-Hours

SHIPPING

The proceeding steps can be followed when sending an engine to our facilities:

1. Drain all oil from the engine, mini sump and oil lines:
   - If you can run the engine, do so to thin the oil for more effective drainage
   - If you cannot run the engine prior to draining, open all drainage points (drain cocks, sump and dis connected lines to the engine) and allow to drain over several days

2. Drain Fuel:
   - Disconnect the engine from the fuel tank
   - Drain fuel from carburettor and fuel lines
   - Allow time for any residual fuel to evaporate

3. Remove the engine from the air frame (if applicable)

4. Clean away any leftover surface oil and residues

5. Remove the following and allow the engine to take a minimal height when packed in an engine crate:
   - Starter Motor (look for thrust shim)
   - Alternator
   - Carburettor
   - Distributor Caps

6. Plastic wrap any small parts being shipped with protective foam or bubble wrap. Ensure smaller items are secured so they cannot be damaged in the crate during transit

7. Make a wooden base plate:
   - Cut a 400mm x 400mm x 19mm ply plate
   - Cut 4 blocks 165mm high and approximately 70mm x 90mm wide
   - Drill a 9/16" diameter x 90mm deep hole in 2 blocks for an R2800 and 4 blocks for an R3600. These are to accommodate the engine mount pins (see Figure #)
   - Position blocks in a square of an approximately 250mm (see Figure #). The blocks themselves are screwed to the ply plate via long screws from beneath the 400 square ply plate. Then the ply plate with blocks attached is screwed down from the top of the floor of the engine crate.

8. Prepare a 990mm x 990mm x 810mm tall (39" x 39" x 32") crate:
   - Start with the 990mm x 990mm x approximately 5/8" - 3/4" thick base plate first
   - Add a couple of wooded rails underneath so as a forklift can slide its forks under for lifting
   - Make the 4 990mm x 810mm box walls out of 1/2" ply
   - When the lid is placed on top, it's not a bad idea to make sure the lid is placed so as the engine is sandwiched and can't jump off the 4 wooden pedestals
   - For overseas customers, locate a certified box builder that is ISPM15 compliant for entry into Australia. The box builder is used to have the crate stamped and to provide a compliance certificate. Without this, the engine could be quarantined (it is the non-certified crate that causes the problem) and you will be charged a fumigation expense by Australian quarantine inspectors (approximately $250USD). The few extra dollars spent to have compliance certificate can save you time and money. If you build the crate yourself, the timber used must have a ISPM15 compliance stamp. Even if you have the original crate your engine arrived in, you still need to get a compliance certificate.

NOTE:

If applicable, the engine can be transported with all cylinders removed. This is to reduce shipping costs as the create is much smaller.

SPARE OR REPLACEMENT PARTS

Rotec offers a variety of spare and replacement parts. Please contact Sales@RotecAerosport.com for more details on the following packages.

Emergency Kit:
Covers most items which are hard to source outside of Rotec. These parts are common service items and can be used as replacement parts in the field. Sometimes called the survival kit.

Contents:

R2800	R3600
1 x Hall Sensor	1 x Hall Sensor
1 x Electric Ignition Module	1 x Electric Ignition Module
1 x Fan Belt	1 x Fan Belt
2 x Rotor Buttons	2 x Rotor Buttons
1 x Wiring Harness	1 x Wiring Harness
2 x Distributor Cap Clips	2 x Distributor Cap Clips
14 x Rocker Cover Gaskets	18 Rocker Cover Gaskets
1 x Anti-Drain Oil Filter	1 x Anti-Drain Oil Filter
1 x Scavenger Filter	1 x Scavenger Filter
1 x Magneto Coil	

Rocker Cover Replacement Kit:
Contents:

R2800	R3600
14 x Radial Rocker Covers	18 x Radial Rocker Covers
14 x Radial Rocker Cover Gaskets	18 x Radial Rocker Cover Gaskets
28 x Copper Washers	36 x Copper Washers

Electric Oil Scavenge Clean Kit:
Contents:

R2800 & R3600
1 x VDO Electric Oil Scavenge Pump
1 x Electric Scavenger Fitting Kit
1 x Connector Plug

ENGINE MAINTENANCE

LUBRICATION

Oil Change, Oil Filter(s) Change, Visual Check for Leaks.

- Drain warm oil from both the scavenge sump and main oil tank.
- Change the main oil filter and the in line scavenge filter.
- Fill oil in oil tank min full level of 6 litres.
- See Chapter subsection 'Engine Oil Recommendations' (p. 26) for oil types

AIR INTAKE FILTER

Clean filter by blowing compressed air against direction of air flow.

In extreme conditions clean or replace filter at shorter than recommended intervals.

NOTE:

A clogged or restricted air filter can reduce best engine performance. Not to mention promote premature engine wear.

CARBURETTOR ADJUSTMENT

Open the mixture screw 1-2 turns, fine adjust for smooth idle. The determination of the main jet is factory set at full power, full load with an EGT (Exhaust Gas Temperature) reading of 600+-20 deg. C .

IMPORTANT

Check all carburettor couplings both fluid and mechanical are integral and secure. Throttle butterfly should spring return to FULL power or open and choke should spring return to OFF or lean.

COMPRESSION TEST

The compression of each cylinder can be measured with the use of a compression air gauge fitted to a spark plug hole. With the engines fuel and spark sources all switched OFF crank the engine via the starter motor with the carburettors butterfly wide open, crank until a max reading is obtained. Oil should be warm. Readings should not fall below (90 psi). See Cylinder Compression Testing in Engine Tunning & Trouble Shooting chapter, (p. 81).

SPARK PLUGS

Do not sand blast or use similar abrasives to clean spark plugs. Also never wire brush or buff plugs this can transfer thread damage to delicate ally cylinder head spark threads. Instead clean with soft nylon brush and solvent. Check electrode gap is adjusted to 0.55 – 0.60mm (0.022" – 0.024").

IMPORTANT:

Only tighten plugs on a COLD engine and torque to correct value of 11nm or 8ft.lbs. For insurance against thread seizure use Loctite Nickel anti seize on all spark plug threads.

Note:

After engine operation spark plug colouration can give a good indication of operating conditions from within the combustion chambers.

Colouration	Signifies
Light Tan - Gray Colour	Indicates good mixture.
Very Light/Chalky White or Melted end	Too Lean mixture.
Black Velvet Colour	Indicates too rich mixture.
B;acl wet/glossy	Indicates oil and or too rich mixture.

EXHAUST & INTAKE SYSTEM

Routinely perform general visual checks for leaks, security and abrasions. If leaks are detected, have the exhaust system repaired or engine damage could result.

ALL BOLTS & NUTS

Check for tightness, re-torque if necessary (see torque spec chart p. #).

TAPPET ADJUSTMENT PROCEDURE

Tappet clearance must be set at COLD 0.10mm (0.04") for both the intake and exhaust valves.

The easiest technique to set the tappets is described as follows:

- Firstly the Rotec Radials, like all four stroke engines fires each cylinder every alternate revolution so the piston arrives at Top Dead Centre (TDC) twice every four strokes of the piston. The two (TDC) stokes are named both the exhaust stroke and compression stroke.

- We are only interested in the compression stroke as this is when the valves are both shut and the piston is compressing the mixture while it ascends toward the head or TDC.

WARNING:
Make sure both spark sources and fuel supply are switched OFF.

- With one spark plug of each cylinder removed a simple method is to place one of your fingers over the open spark plug hole of the first cylinder to be tappet adjusted

- Rotate the engine by hand until you feel the air trying to rush past your finger this is the piston ascending toward TDC compressing the air in the cylinder as it does. When the piston reaches TDC and then descends back down the cylinder bore, a suction will be felt on your finger stop and come back by reversing rotation. You are now very close to where you want the piston and valves to be.

- Now place a blunt thin rod like a pen or dowel (don't drop it) and feel the piston come up, jog the crank back and forth until you are approx. at TDC on this the compression stroke. This is close enough for setting the tappets only.

- Now set the tappets on this cylinder using a 0.10mm (0.04") feeler gauge shaped with a bend at the end so as to sneak it between the tappet and the valve stem from the rear of the rocker box. Repeat this technique on the remaining cylinders tappets in a counter clock wise direction (Front perspective) until all 14 tappets are set.

- Go around once again to confirm that all tappet lock nuts are tight.

- Also care should be taken not to "dislodge" a push rod from the cup of the rocker as this will jam and may bend a push rod in the rocker box if not detected. This is more prevalent on the horizontal cylinders. A thin piece of welding wire with a small 90deg bend at its end can aid re- locate the fallen pushrod. Rocker pin removal is advised when attempting to re- locate pushrods.

- Correctly adjusted tappets are vital for valve train longevity not to mention smooth and quiet valve operation.

- Check the condition of the 1.5mm o ring cord / gasket and replace if needed, also check the copper washers under the M6 rocker cover cap screws.

NOTE:
The M10 x 1mm 'O-rings' at each end of the rocker pins, these pins when tight, NEVER lock and can rotate with spanner force only.

ENGINE TUNING & TROUBLE SHOOTING

ENGINE INVERSION

To enable inverted use for the Rotec Radial, the following is required:

Fuel Supply:
- Fully Aerobatic Fuel System such as the Rotec TBI
- Electric Fuel Booster Pump
- Fuel Tank with internal flop tube (not available from Rotec Aerosport)

Oil Supply:
- Oil Tank with internal flop tube (not available from Rotec Aerosport)

VALVE LASH

Valve lash or valve clearance on any Rotec Radial should be set to 0.1 mm (0.004''), cold engine.

A rule of thumb method for achieving this valve lash is:

1. Seat the valve adjuster to the seat on the head on the valve.
2. Loosen the valve adjuster 1/8th of a turn.
3. Tighten the valve adjuster so it can no longer move.
4. Confirm with a feeler gauge the correct valve lash has been set.

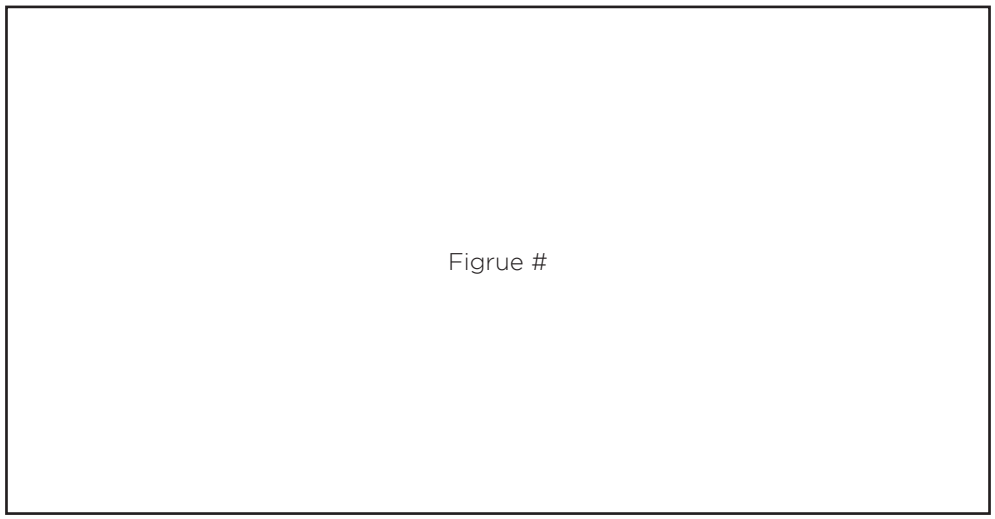
It is recommended that valve lash is checked annually. Please contact us for more information.

IGNITION MODULE & PIN PLUG OUTLETS

Wire numbers on the ignition coil plug are:

1. Negative side of the ignition coil (-)
2. Ground (earth)
3. 3-pin hall sensor plug negative outer pin (black wire)
4. Positive side of the ignition coil (+)
5. 3-pin hall sensor plug positive center pin (red wire)
6. 3-pin hall sensor plug pulse groove (white/brown wire)
7. Tachometer pulse (optional)

Wires numbers are represented by the number of marks on the wire. For example wire 3 will have 3 marks. For graphic representation of wiring diagram, see the installation guide.



(Fig #. example)

ROCKER COVER OIL LEAKS

If oil is leaking from the rocker covers, the following options are available:

- Purchase replacement gaskets, to replace the existing damaged gaskets. Sometimes after repeated use cork gasket require replacing.
- Copper washers will likely require replacing also as their sealing ability diminishes after multiple uses.
- Ensure rocker covers have concave sealing faces. A rocker cover with a flat sealing surface, let alone convex, has inferior sealing ability as a concave sealing face applies tension to the far edges of the gasket surface from where the bolts are torqued down.
- To test if the rocker cover is concave, place it on a flat surface.
- Rocker covers can be carefully bent to be concave by placing a 1 mm thick shim (alternately a 6'' ruler) under the centre running across the bolts. Press down at both ends with a press or vice to slightly distort the rocker cover.
- Using a 5 mm hex key, torque settings for rocker cover screws (M6 X 25) are to be between 8 – 9 N·m (70 – 80 lbs·in).

CYLINDER COMPRESSION TESTING

The compression of each cylinder can be measured with the use of a compression air gauge fitted to a spark plug hole.

PROCEDURE:

- Run the engine as normal to warm the oil
- Switch off the engines fuel and ignition sources
- Remove the propeller if installed. The engine will be safe as it is tested using the starter motor only. It will therefore have minimal power applied without a load.
- Remove one lead then spark plug of each cylinder to give the gauge access and reduce load on the starter motor when cracking
- Set the throttle to WOT
- Apply the gauge to the cylinder and crank the engine via the starter motor
- Crank until a maximum reading is obtained

RESULTS:

Engine Condition	Acceptable Range*	Requires Rectification
New	120 - 150 psi (830 - 1030 kPa)	< 120 psi (830 kPa)
Used	90 - 150 psi (620 - 1030 kPa)	< 90 psi (620 kPa)

NOTE:

* Values exceeding this range will mean oil is present in the cylinder and is of no concern. This will be most common on lower cylinders and means the engine has not been run before testing. Readings between cylinders will also vary slightly due to the natural differences of stroke on a radial engine.

POTENTIAL CAUSES & RECTIFICATION:

- Piston rings require replacing
- Valves require re-seating
- Head requires replacing as it is leaking

ENGINE TUNING & TROUBLE SHOOTING

GEARBOX NOISE (PSRU)

A noisy gear box (PSRU) will not be gear back lash as measured at the prop tip. It will more likely be the bell gear spline shifting ever so slightly on the crank spline. This is the reason why all Rotec Radial Engines now have a press fit on this spline.

FIX:

- Remove the bell gear.
- Clean all oil and debris using solvents and a tooth brush.
- Prep the area with anaerobic adhesive primer. Once dry, apply anaerobic adhesive (Loctite 638) over the splines and re-assemble the bell gear.
- Torque the bell nut to 50 ft/lbs. Or a quick burst on the in pact gun, but NOT too much or you can pull the end of the crank thread off! (Rattle guns can apply over 250 ft/lbs).

There is no need to safety wire the bell nut just use the same anaerobic adhesive on the thread and it will never come loose.

The anaerobic adhesive method will buy you around 100 – 200 hrs before it needs to be redone.

IGNITION TESTING

HALL ELECTRONIC TEST PROCEDURE:

Summary:

1. Remove center coil lead from LHS distributor cap
2. Add a spark plug to the end of a coil lead
3. Ground the spark plug body. This can be achieved by simply grounding it on bare metal of the airframe.
4. Power up the ignition system
5. Check for +12V DC at positive terminal of ignition coil
6. Disconnect three pin Dean's plug from LHS distributor
7. Check +12V DC at center pin of Dean's plug
8. Check for ground (earth) -12V DC from outside pin furthest away from groove pin
9. Using a small 12V globe (for reference, see Figure 1), short both outside pins together (groove pin and earth pin) then release.

- Every time the short is released a spark should jump at the spark plug.
- If the spark jumps then the module is good and the sensor bad.
- If no spark, then module or wiring is bad.

Warning:

Disconnecting the battery from the engine while running can lead to electrical problems. Modern alternators are different to old aviation alternators. An inbuilt regulator controls the current output of the alternator that changes the amount of field voltage that supplied to the rotor. The more voltage supplied to the field, the more current output from the alternator. Therefore, suddenly removing the battery the circuit causes the alternator to send out a voltage spike, as it can no longer can sense the line current of the electrical system. This voltage spike can potentially damage the hall sensor and ignition module.

STARTING ISSUES:

The R2800 magneto cannot produce enough spark at cranking speeds to fire the engine, as it has no impulse coupling.

The electronic ignition kicks things off as this produces a very hot spark at any speed, even hand propping. As soon as the engine has started on the electronic ignition the magneto kicks in as soon as the magneto rotor speeds up.

This is most likely why your engine will not start. If only the magneto is running, the spark is too weak at cranking speeds to ignite fuel in the engine. Refer to the Hall Electronic Test Procedure for more information. For further technical information or spare parts (see Figure 3), contact us.

LOWER CYLINDER OIL LEAKS

Oil and radials come hand in hand. After shut down oil must drain to the lower cylinders. Oil will weep past the piston rings and if an exhaust valve is open it will end up on the floor. If an inlet valve is open, it will fill the intake pipes. That is why intake drains on the lower cylinders must be open at all times when the engine is shut down to prevent hydraulic lock.

After shutdown, we recommend you attached containers on the exhaust pipes to catch oil as it drains. You can catch oil from the intake drains by connecting 1/2'' hose. Drained oil is always reused by using a strainer and funnel to recycle it back into the oil tank. The Rotec Radial can fill the containers by up to 2 liters after shutdown, making recycling important.

Oil can also siphon from a high mounted oil tank. To stop this use an anti-drain back oil filter or oil shut off tap between the oil tank and inlet of the oil pump.

The electric oil scavenger pump helps to minimize oil loss as it pulls all unwanted oil out of the engine after shutdown.

Aside from the exhaust and intake drains, oil should not leak from other areas.

STORAGE & PRESERVATION

GENERAL

The following procedures assume that the engine is fitted to an air frame; refer to the manufacturer's service manual for all airframe recommendations and procedures. If the engine is not fitted to an air frame, ignore those items referring to the airframe.

- Flyable storage is defined as a maximum thirty days of non-operation.
- Indefinite storage is defined as engine in the non-operation status for a maximum of 90 days.

CORROSION & STORAGE

To avoid engine wearing rust from forming on the steel cylinder walls, Rotec Aerosport strongly recommends that engines kept in permanent or long term storage should have their cylinders lubricated with oil every 30 days. Simply remove one spark plug from each cylinder and spray oil into the cylinder through the spark plug hole. Rotate engine several times; then repeat with oil a second time followed by NO rotation.

This procedure should be repeated every 30 days.

Rotec engines made in-serviceable by this preventable situation fail to be covered via warranty.

CAUTION:

AVGAS 100LL fueled engines left long term can form rust on cylinders. That's the reason why we recommend that radials be ground run on unleaded fuel at 60% power just prior to anticipated long term storage.
Rotec has established that engines with zero (or negligible) internal corrosion were those whose owners had performed the short run on unleaded fuel and oiled the cylinders as instructed.

FLYABLE STORAGE

Flyable storage is defined as a maximum thirty days of non-operation. Ensure that the engine had been shut down by starving the carburettor of fuel by closing off the main fuel supply tap. Rotate the propeller 5 times (Ignition and fuel OFF) weekly without running the engine. Leave the propeller horizontal to allow liquids with in the prop to remain neutral and not drain to one tip thus causing a potential in balance.

AVGAS 100LL is the recommended fuel for all Rotec radial engines.

However, AVGAS 100LL fueled engines left long term can form rust on the cylinders. Because of this, Rotec Aerosport recommends that their radials be ground run on unleaded fuel at 60% power just prior to anticipated long term storage.

Rotec has established that engines with zero (or negligible) internal corrosion were those that had been short run on unleaded fuel and oiled cylinders.

NOTE:

After 30 days, if continued storage is intended, repeat all the above.

CORROSION AVOIDANCE

To avoid serious rust forming on the steel cylinder walls, Rotec Aerosport strongly recommends that engines kept in permanent or long term storage should have their cylinder lubricated with oil every 30 days. Simply remove one spark plug from each of every cylinder and spray oil into the chamber. Rotate engine several times, then repeat with oil a second time followed by NO rotation.

WARNING:

This procedure should be repeated every 30 days.

Radial engines have been made serviceable by users ignoring this warning. Not following this procedure will void the warranty.

INDEFINITE STORAGE

To maintain the integrity of an engine that requires long term storage, whether on or off an air frame, the following is recommended every 90 days:

1. Fuel tank:
- For temporary storage, (non-operation status for a maximum of 90 days), fill the tank(s) with correct grade of petrol to prevent moisture accumulation.
- For indefinite storage, drain both the fuel tank and carburettor bowl of all fuel

2. Disconnect spark plug leads and remove one spark plug from each cylinder

3. The chrome molly steel cylinders are chemically blackened preventing external rust, although internally they rely on oil to prevent corrosion. With the piston down (BDC), use a spray atomiser to spray Anti Corrosion Oil through the spark plug hole of each cylinder. Possible Anti Corrosion Oils include:
- Shell Aero Fluid 2XN Anti Corrosion Oil
- WD-40 or similar penetrating oil

4. Rotate the crankshaft by hand to lubricate any reciprocating components

5. Reinstall the spark plugs and leads

6. Seal all exhaust openings. Attach a red ribbon to each seal. **DO NOT** seal the fuel tank breather.

7. Attach a placard to the engine informing of storage status. Engine should not be hand rotated and **MUST NOT** be started with seals in place.

8. After 90 days, if continued storage is intended, repeat all the above steps.

All exterior aluminium components are made of 6000 series aluminium, which is highly corrosive resistant.

Keep in mind that an unsheltered engine will be exposed to more:
- UV radiation, accelerating the degradation of rubber components
- Moisture, potentially causing rust of steel components
- Dust and contaminates

NOTE:
After 90 days, if continued storage is intended, repeat all of the above.

ASSORTED SPECIFICATIONS

TORQUE SPECIFICATIONS FOR USER

Part:	Nom. Dia. (mm)	Torque (Nm)
Spark Plugs	12	11
Prop Nut (5mm split pinned)	20	210
Oil Pump Cap Screws	6	20
Rockers Covers	6	7
Starter Nuts (Nyloc)	10	25
Carburettor Flange Bolts	6	20
Engine Mount Plate Bolts	8	30
Alternator Mount Bolts	8-10	20-25
Upper Scavenge Pump/Dist. Bolts	8	25
Scavenge Sump Nuts (Nyloc)	6	20
Fuel Pump Bolts	8	25
Nose Bowl Nuts (Nyloc)	6	80"/lbs
Front Prop Seal Retainer Bolt (lock wired)	6	20
Cylinder Flange Nuts (Nyloc)	8	30
Intake & Exhaust Bolts	8	25
Magneto Coil Bolts	5	10

PRESCRIBED SEALANTS & PRIMERS

Item:	Sealant:
Oil Pump Bolts	Loctite 620
Distributor/Scavenge Pump Bolts	Loctite 262
Carburettor Manifold Bolts	Loctite 262
Front Oil Seal Retainer Bolts	Loctite 620
Magneto Coil Bolts	Loctite 262
Main Centre Prop Flange Nut	Loctite Nickel Anti Seize
Spark Plugs (NGK DCPRBE)	Loctite Nickel Anti Seize
Rocker Covers	Glue 1.5mm O-Ring Cord to inner face
Rocker Cover Screws (No Loctite)	Place M6 Copper Washers under all 28 Cap Screws Place 1 x 10mm O-Ring under each end of Pin
*Tighten finger tight to seat, then with a 5/8" plug socket tighten an additional 1/2 turn (11Nm) for a new plug.	
*** For the easy removal of Loctite "Gasket Eliminator" 515, use Loctite "Chiselit" gasket remover in aerosol form. (Avoid contact with skin, plastic or painted material).	