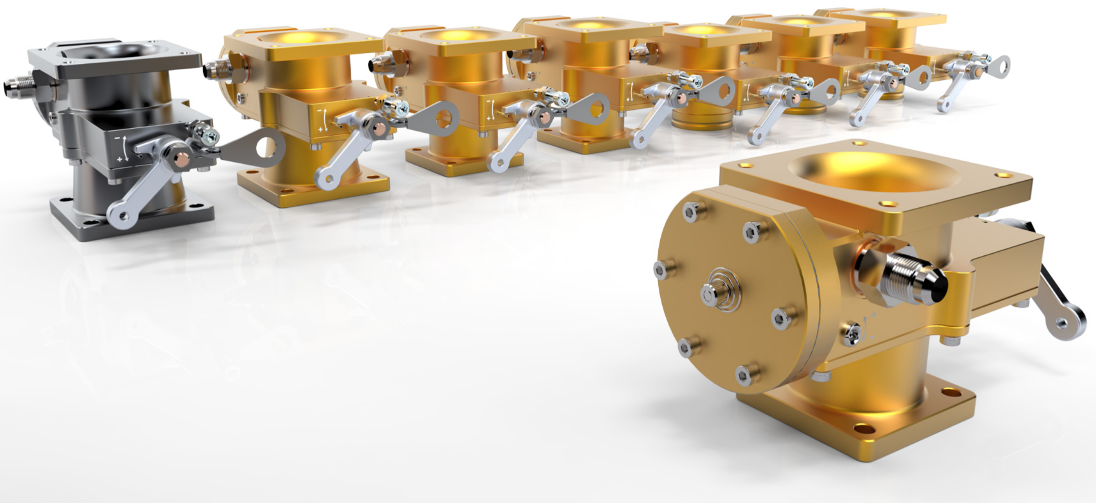
ROTEC AEROSPORT

TBI-Mk.II CUSTOMER MANUAL



WARNING:

IMPORTANT

Altering your aircraft's fuel delivery system is dangerous.

This procedure can have drastic consequences if rushed or done poorly. Incorrect installation and operation can cause malfunction of equipment and engine failure.

By using the Rotec Throttle Body Injector, you stand to make significant gains in the performance of your aircraft's engine. However, there are severe risks involved should your installation and tuning be done incorrectly.

The contents of this manual aim to make your installation as successful as possible with safety always being paramount.

NOTE:

Please pay close attention to any text that appears inside boxes. It is important information that should not be ignored.

CAUTION

WARNING

FOREWORD:

CONGRATULATIONS

You are now in the envious position of owning of a Rotec Throttle Body Injector. This TBI is the most compact and simple throttle body injector on the market. Its unique fuel distribution system makes it easy to setup and operate. With excellent power per volumetric flow, smooth mixture control and a variety of models to suit any engine, the system is a must for any serious experimental pilot.

Fuel delivery and pressure are controlled by the ‘on demand’ fuel metering regulator, supplying the precise amount of fuel to the engine. This system is truly self regulating and is not effected by fluctuating fuel levels or pressures.

Everything you need to know about this unique device from installation and operation to tuning and servicing, is detailed in this manual.

From the team at Rotec, ENJOY!

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GENERAL INFORMATION

INTRODUCTION

This manual provides complete information for the installation, operation, and maintenance of the Rotec Throttle Body Injector (TBI). This device offers improved aircraft engine performance and economy when installed and operated in accordance with this manual.

> **NOTE:**
> **The Rotec TBI described herein is designed for experimental aircraft and as such is only approved for use in this category.**

DESCRIPTION

The Rotec Throttle Body Injector (TBI) is a variable venturi, diaphragm controlled, fuel metering device configured to supply the fuel and air requirements of several popular aircraft engines. It will operate in any attitude and through a wide range of G-loads, making it an attractive replacement for carburettors or fuel injectors.

APPLICATION

The Rotec TBI is available in the seven models listed below. Adjacent to each model is a list of engines having airflow and fuel flow requirements compatible with that model. The Rotec TBI Fuel System can be used on motorcycle, car & boat engines. It does not interact with any electronics and is therefore an independent fuel system.

TBI Model	Appropriate Engines	Dual Units Required
MKII 34-R	Rotax 582 Rotax 503	Rotax 912 Rotax 914
MKII 34-S	Jabiru 2200	
MKII 34-2	VW 1800-2100cc, VW Great Plains, EA-81 Subaru	
MKII 40-S	Jabiru 3300, Rotec R2800, Rotec R3600	Jabiru 5100
MKII 40-3	Lycoming O-235, Lycoming O-290, Rotax 912, Continental C75, C85, C90 & O-200	
MKII 40-4	Lycoming O-320	
MKII 48-4/5	Lycoming O-360, Lycoming O-540, Continental IO-360	

PRINCIPALS OF OPERATION

The Rotec TBI shown in the section view below is a unique fuel metering device. The fuel is injected in the plane of maximum airflow velocity, through a matrix of very small metering holes located in a tube extending across the entire width of the airflow passage.

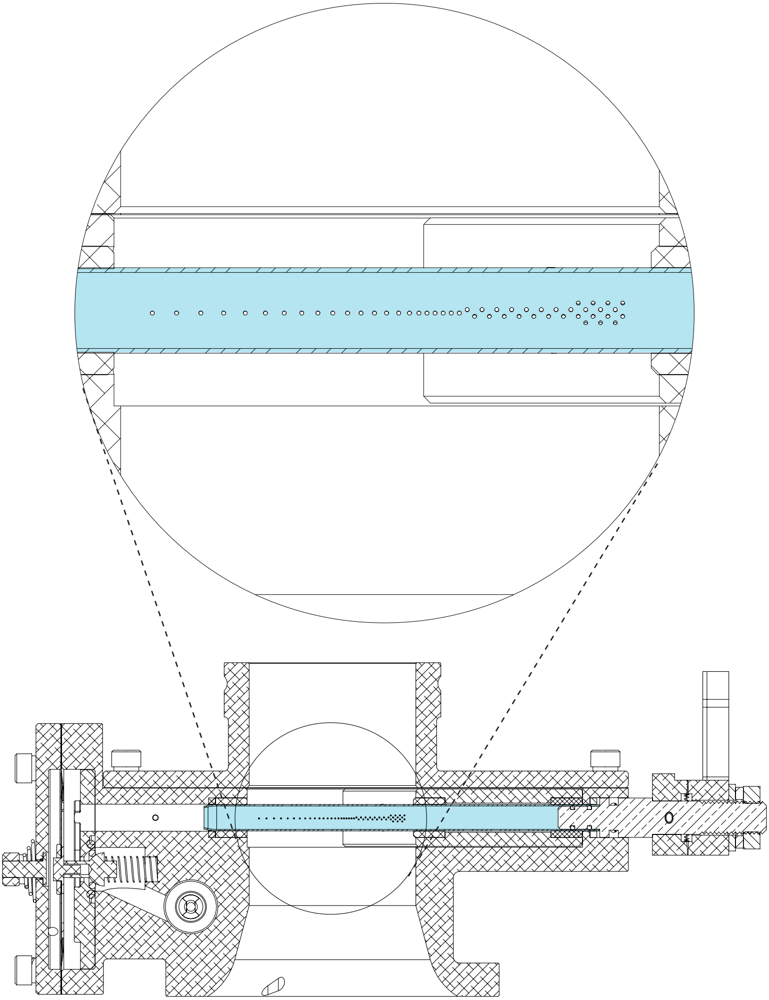


Figure # 1

Fuel is admitted to this metering tube by an “on demand metering” regulator, designed to maintain a slightly negative pressure in the metering tube. This metering tube is positioned in a bore through the throttle slide.

Movement of the throttle slide thereby controls fuel flow as well as airflow by changing the number of metering holes exposed to the air stream.

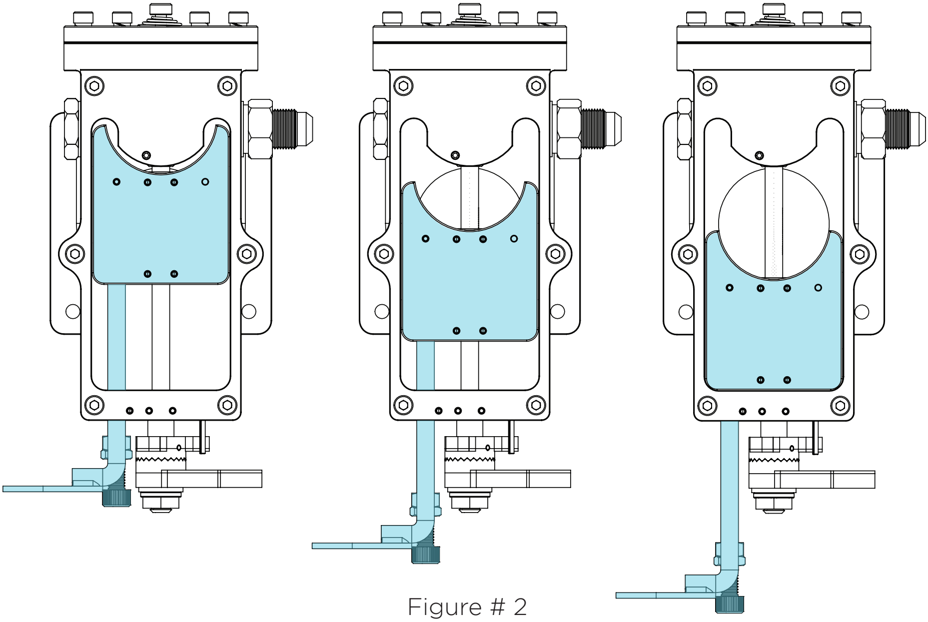


Figure # 2

Rotation of the spray bar tube through a maximum angle of 90 degrees changes the orientation of the fuel metering holes with respect to the airflow. This rotation serves as the pilot's mixture control.

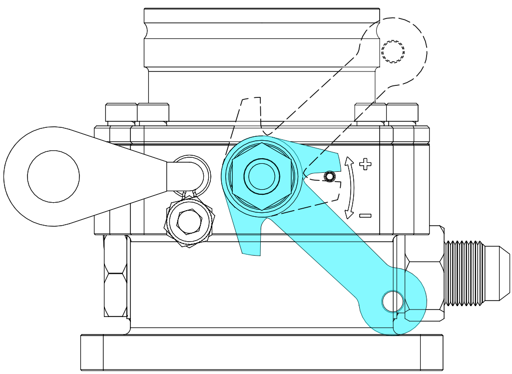


Figure # 3

Full Lean occurs when the holes are directed towards the on-coming airflow, and a progressively richer mixture is obtained as the holes are rotated away from the zero angle of attack position. Full Rich occurs when the holes are directed perpendicular to the air flow, allowing for maximum suction of fuel from the spray bar via the air flow.

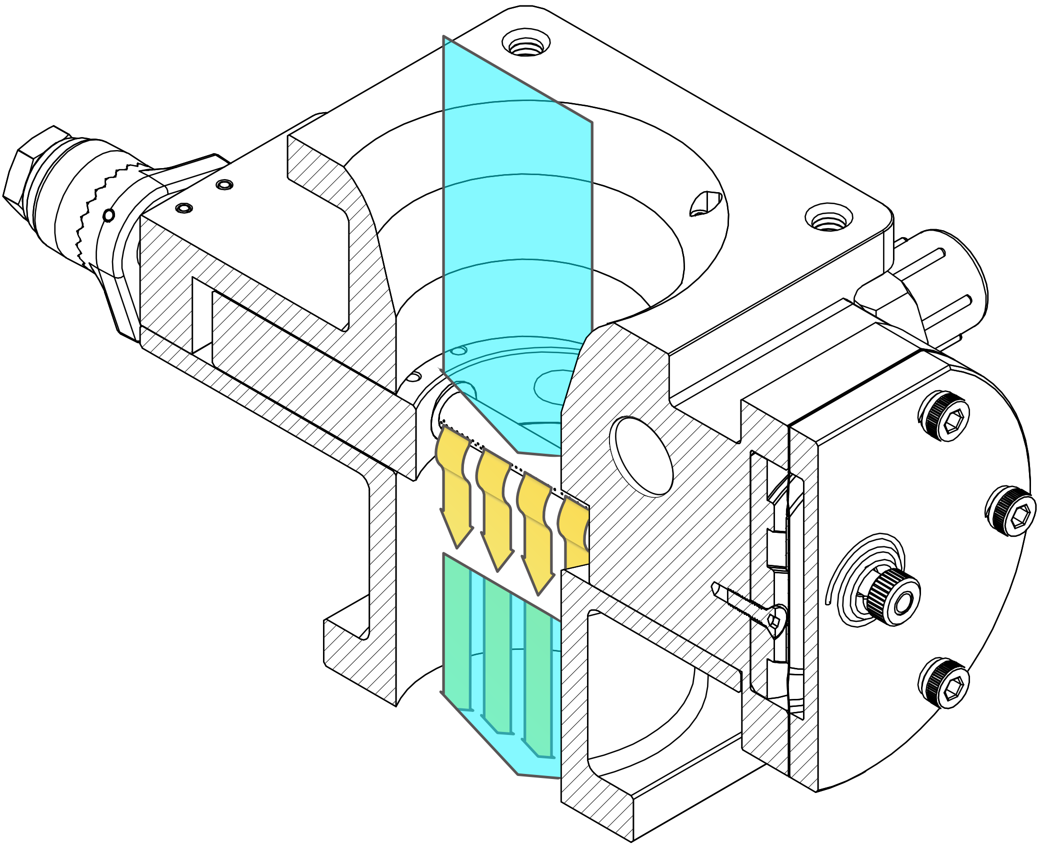
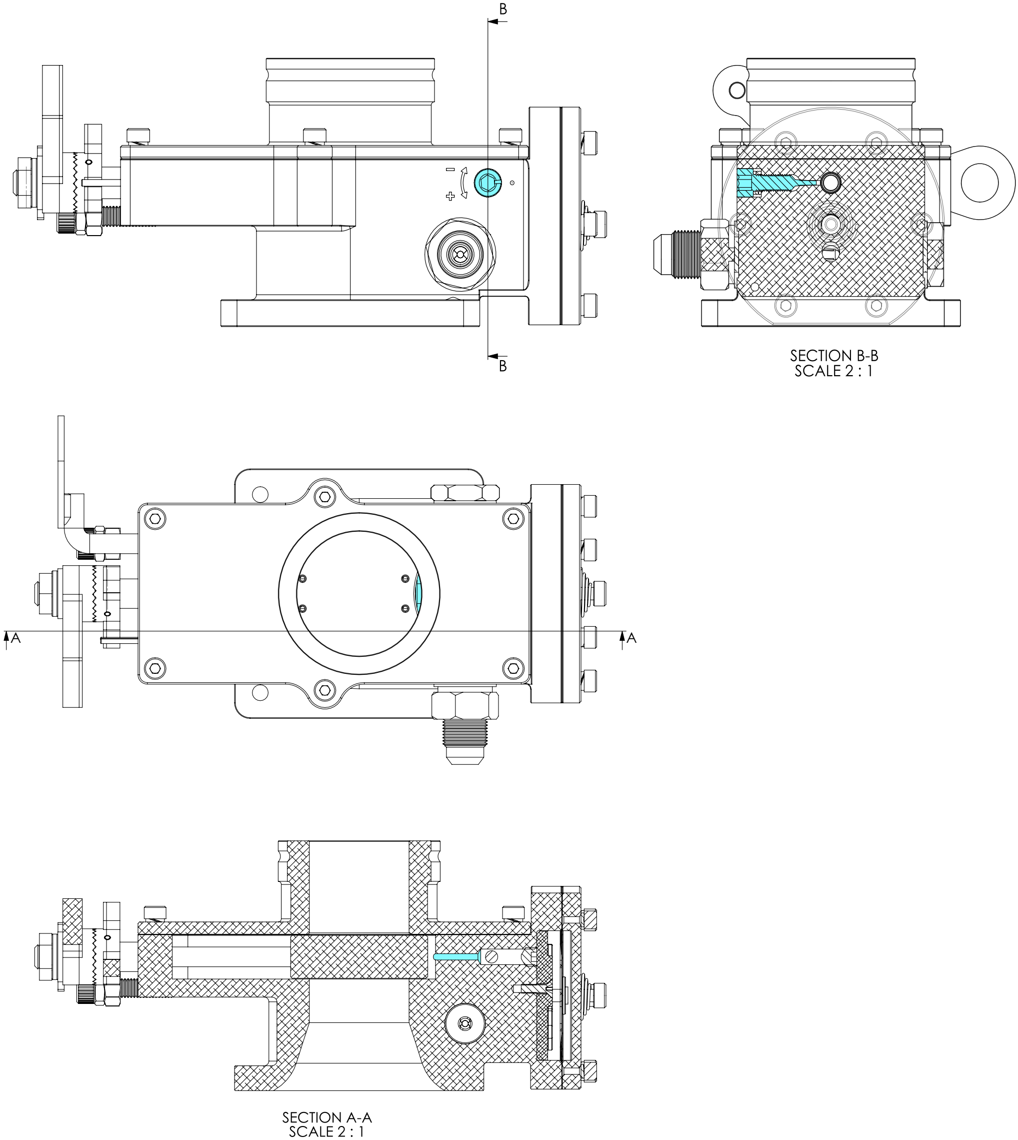


Figure # 4

Because the fuel pressure in the metering tube is maintained below ambient pressure, fuel will not flow from the metering holes unless induction air is flowing through the inlet bore. This feature permits the engine to be shut down without the necessity of turning off the main fuel valve.

Idle fuel is dispensed by an idle fuel jet whose discharge rate is adjusted by a conventional needle valve located in the regulator end of the body. Idle fuel flow allows a constant, minimal supply of fuel to the engine, no matter what position the throttle is in.

Figure # 5



FUEL COMPATIBILITY

The Rotec TBI has been designed specifically for aircraft use and has been thoroughly tested with aviation fuels.

Fuel Type	Works With Rotec TBI	Comments
Aviation Gasoline (Avgas)	YES	Least susceptible to vapour lock
Automotive Gaso-line (Mogas)	YES	More susceptible to vapour lock
Ethanol Blend	YES	Rubber components such as seals and the regulaor diaphragm are ethanol resistant
Two-stroke Engine Blend	YES	Fuels containing lubricating oil will not cause damage
Kerosene/Diesel	NO	Untested

AEROBATIC

The Rotec TBI Fuel System can be mounted to an engine at any attitude and at any angle. It can even be mounted upside down, making it the perfect aerobatic fuel system. The system has no float, so it can fly at any attitude.

PERFORMANCE BASELINE

It is suggested that prior to beginning the installation of the TBI, the aircraft be flown through the flight test outlined in Section 6 (p.51) of this manual, using the aircraft’s original fuel metering system. Later comparison of this data with post-installation data will quantify the performance benefit or penalty resulting from the TBI installation.

In order to assure accuracy, it is very important that the test be flown in smooth air, preferably in the morning. It is also important that the aircraft be properly trimmed and allowed several minutes of hands-off level flight to stabilize its speed before any performance data is recorded.

INSTALLATION:

PLANNING

Because of the many differences between the TBI and the aircraft's original fuel metering system, it is very important to carefully plan the routing of all linkages, plumbing, and ducting components before beginning the permanent installation.

Like other diaphragm fuel metering systems, the TBI will experience momentary power loss when momentary interruptions in fuel flow occur. This can result from the formation of vapour or the ingestion of air from leaks in the fuel system.

Below is a list of potential vapour or air leak sources that should be considered during the planning phase of any TBI installation.

1. Boost pump, gascolator, fuel filter, and fuel valve should preferably be located outside the engine compartment or mounted together and blast cooled.

2. Boost pump should be located below the level of the fuel in the tanks.

3. Engine driven fuel pump should be shrouded and blast cooled.

4. Fuel lines in the engine compartment should be insulated by fire sleeve and protected from radiant heat sources (exhaust pipes) by reflecting baffles.

5. Minimize the number of fuel line fittings, especially 90 degree elbows, and limit the length of the fuel line, especially in the engine compartment.

6. Maintain constant upward slope of fuel line from the boost pump (i.e. avoid high points or loops where air bubbles can accumulate).

7. On aircraft with improperly baffled fuel tanks, the fuel tank fuel line. In such cases, long slips and sharp taxi turns before takeoff should be avoided while operating with low fuel tank levels.

8. Avoid fuel system complications which invite errors in fuel management.

9. Loose fittings, defective O rings, split flares, or improperly installed components such as primer pumps and gascolator seals, can be a troublesome source of air leaks and are usually difficult to identify.

INSTALLATION REQUIREMENTS

In order for the Rotec TBI to perform satisfactorily and dependably, the finished installation must include the following features:

A. Inlet air filter

B. Induction air system

C. Cockpit throttle stops, open and closed

D. Cockpit mixture control stops, rich and lean

E. Fuel filter, 40 micron or finer

F. Fuel pressure requirements:
All Models require 0.5 to 15 psi.

G. The aircraft fuel system, up to the point of connection to the TBI, including lines, filters, pumps, valves, and fuel flow sensors, must demonstrate the capability of flowing 150% of the rated power fuel requirements of the engine when operating on the last gallon of fuel in the tank. This flow capacity must exist when the aircraft is at the pitch attitude yielding minimum fuel head and with the fuel boost pump operating.

H. Fuel tank vents in all tanks

MOUNTING

Because the Rotec TBI uses a diaphragm in lieu of a float chamber, the unit may be mounted in any position. There are a few positions which should be avoided if possible.

On Continental and Lycoming engines, the TBI must be mounted in an orientation that places the spray bar tube in a horizontal plane. If the metering tube is not in a horizontal plane, positive or negative “G” forces acting on the diaphragm will alter fuel metering. Avoid orientations in which the throttle slide moves fore and aft (parallel to the crankshaft), especially in Lycoming engines. The best performance will be obtained when the throttle slide moves in a spanwise direction.

EXISTING FUEL PRIMING SYSTEMS

It is mandatory that the TBI priming system be employed and made functional regardless of whether or not the aircraft has a preexisting priming system. The TBI is used for priming the engine and in emergency situations where fuel is urgently required to keep the engine running. In this instance the engagement of the TBI primer will override the metering flow valve and inject fuel directly into the engine.

INSTALLATION: FUEL

FUEL INLET FITTING

On all TBI models the fuel inlet filter is a 150 mesh finger screen which is quite fragile and must be handled with care if removed. Great care should also be exercised to avoid the introduction of contaminants when removing and replacing the inlet screen or the plug on the opposite end of the filter chamber. Because the fuel inlet screen is a "last chance" filter, the aircraft fuel system must include a primary filter of 40 micron rating or finer.

The body castings of these models incorporate a double ended fuel inlet chamber which has a 9/16 - 18 female thread at each end. The fuel inlet filter may be installed in either end of this chamber. The opposite end contains a plug. The TBI fuel inlet filter is compatible with standard 3/8 inch flared tube fittings found in most aircraft fuel systems.

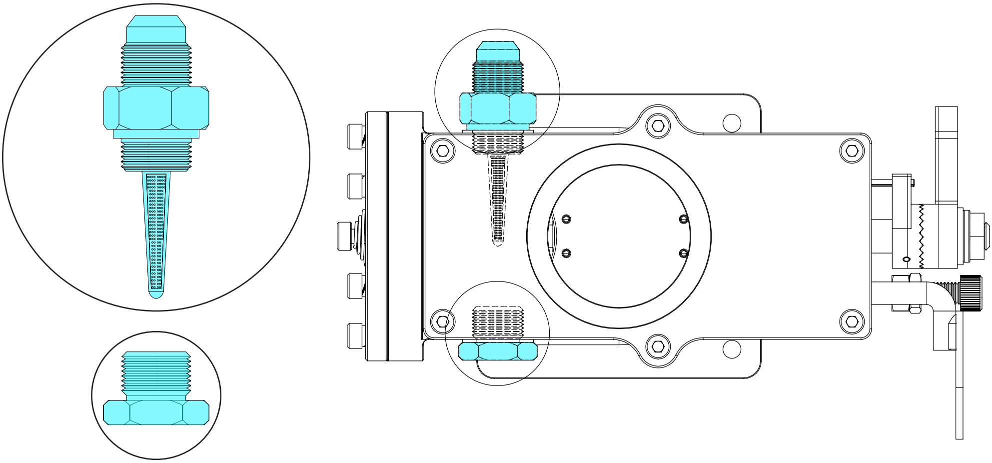


Figure # 6

NOTE

If contaminants are found inside the TBI inlet filter screen, then a failure of the main airframe filter has occurred and must be corrected.

CAUTION

Do not use thread sealing compounds or tape. All fitting joints use a flared tube seat and, if properly installed, require no additional sealing material.

FUEL FILTRATION

The Rotec TBI Fuel System requires the air frame have its own fuel filtration up stream. The fuel filter used with the prior carburettor can be used with the TBI. An automotive fuel filter or gascolator can be added if a fuel filter wasn't present previously. This can be placed anywhere along the fuel line, while keeling in mind the heating of the fuel should be minimised to prevent vapour lock.

The TBI comes standard with a "last chance" filter integral with the TBI body fuel fitting. The filter consists of a very fine 40 micron (0.0016") gauze mesh, designed to stop debris from blocking the TBI spray bar jets, which are holes 0.3 mm (0.01") in diameter.

The TBI "last chance" filter should be inspected and cleaned every 100 hours. Use a 3/4" wrench to remove the fuel fitting housing the "last chance" filter.

Replacement/spare filters are available to purchase individually from Rotec.

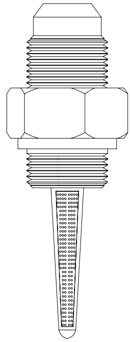


Figure # 7

FUEL SUPPLY

The Rotec TBI Fuel System runs at a broad range of fuel pressures. Typical fuel pressures range between 0.5 - 15 psi. The TBI has been tested with fuel pressures as high as 15 psi. These are not fuel pressure requirements, but instead are recommended provision for adequate fuel flow.

Engines have specific fuel flow requirements. Appropriate fuel flow must be available to the TBI at all times for the engine to run. Engines using the TBI can run with very low fuel pressures where there is adequate fuel flow. Therefore the recommended minimum (0.5 psi) is to allow provisions for flight maneuvers that could disrupt fuel flow.

INSTALLATION: FUEL

GRAVITY FEED

Gravity fed fuel tanks work provided there is adequate fuel flow, even when the fuel tank is almost empty. If gravity fuel feed worked originally, then it will work with the TBI.

It is recommended that the ground tests are conducted at low fuel tank levels and high power settings to confirm whether adequate fuel is supplied at all fuel tank levels.

Upon engine shutdown, the TBI metering regulator will cut off fuel flow, however it is not the sole intension of the TBI metering regulator to perform this duty. For that reason it is highly recommended that airframe fuel shut off tap be used to positively shut fuel supply off to the TBI.

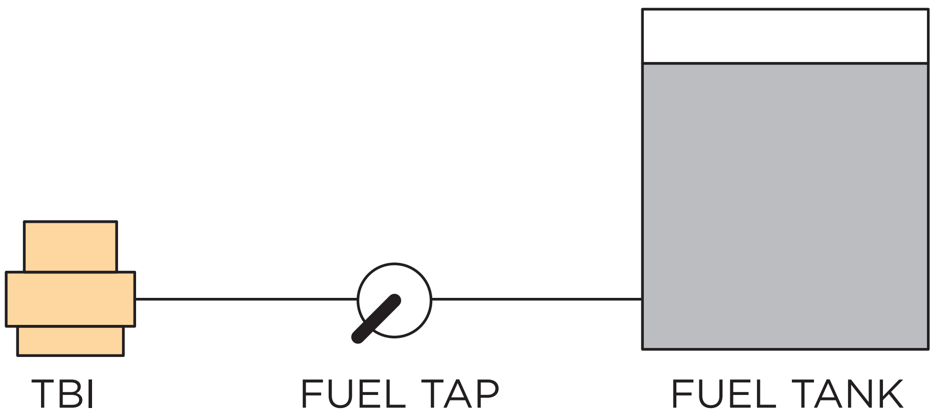


Figure # 8

NOTE

The TBI regulator must always be used, even when using gravity feed. This dynamic metering device alters fuel flow depending on engine demand and is a critical part of TBI function.

ELECTRIC PUMP

The Electric Fuel Pump offers more provision for aerobatics due to the constant fuel pressure supplied. Typical fuel pumps used on piston aircraft engine will fall within correct specification.

Fuel tanks positioned lower than the TBI require a fuel pump.

You should consider the inclusion of a restricted return line for provision against vapour lock.

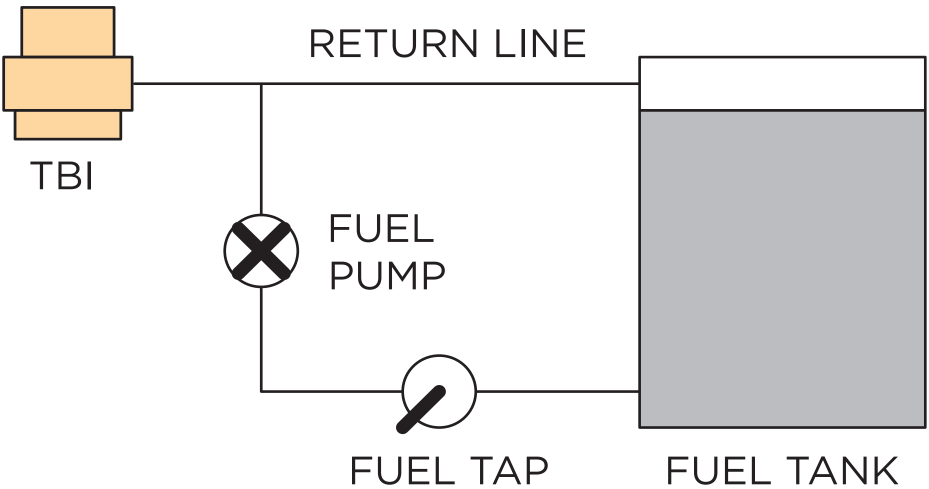


Figure # 9

FUEL DRAIN FITTING

Following engine shutdown, approximately half of the fuel trapped in the regulator (about one teaspoon) will drain out through the spray bar tube and out the intake flange. Provision must be made in the engine compartment to allow this fuel to exit the cowling without creating a fire hazard.

INSTALLATION: THROTTLE

THROTTLE INTRODUCTION

The Rotec TBI Fuel System uses a throttle slide to limit airflow to the engine.

COCKPIT CONTROL

Up to three cables are required to control the throttle slide, mixture arm and primer from the cockpit. Two options are available for controlling the throttle with bowden cables:

<table>
<tr><th>Option</th><th>Where cable (inner) is fixed on the TBI (spacer washer location):</th><th>Moving at TBI:</th><th>Where sleeve (outer) is fixed on the TBI:</th><th>Moving at throttle lever:</th><th>Fixed at throttle lever:</th></tr>
<tr><td>1</td><td>Support bracket</td><td>Sleeve (outer)</td><td>Throttle arm</td><td rowspan="2">Cable (inner)</td><td rowspan="2">Sleeve (outer)</td></tr>
<tr><td>2</td><td>Throttle arm</td><td>Cable (inner)</td><td>Support Bracket</td></tr>
</table>

THROTTLE SETTING

The idle stop is used to set the idle speed (RPM)

The WOT (Wide Open Throttle) stop position of the TBI should be set to stop on the throttle quadrant and not rely on the TBI body. This is to avoid force applied to the roll pin that secures the throttle slide lever to the throttle slide. If a stop on the cockpit throttle quadrant is not used, the user risks damaging the throttle arm by applying excess force when already in the WOT position. You will not need to limit the WOT position of the TBI, unless it is oversized for the engine.

THROTTLE CONTROL SETUP

During engine operation at less than full throttle, a substantial pressure difference exists between the two ends of the throttle slide. This pressure gradient causes a strong buoyancy force acting to close the throttle. This force is greatest at idle and diminishes at increased throttle openings.

Because of the higher throttle friction associated with the TBI, linkage installations utilizing a pull cable in only one direction with spring return in the opposite direction are not satisfactory.

Throttle linkage connection to the TBI throttle control arm must provide movement which is parallel to the throttle control arm within plus or minus 5 degrees. This requirement may be met using a bell crank arrangement or a push-pull cable or rod.

The force required to move the throttle lever should **NOT** exceed 20 N (4.5 lbf), once operating under normal conditions. A levered throttle quadrant is used to operate the throttle slide from the cockpit.

The linear action of the throttle arm has a maximum range of:

<table>
<tr><th>TBI Throat Diameter</th><th>Maximum Linear Throttle Range</th></tr>
<tr><td>34mm*</td><td rowspan="2">40mm</td></tr>
<tr><td>40mm</td></tr>
<tr><td>48mm</td><td>48mm</td></tr>
<tr><td colspan="2">*Able to open beyond the point of full throttle, as it uses the same slide found on units with a 40mm throat. Therefore, the effective throttle range is 34mm. This has no effect on performance.</td></tr>
</table>

The throttle should be operated between power settings progressively.

An aircraft engine with a propeller creates significant load, much like being in high gear in a car. Rapid changes in throttle position, for example from idle to WOT, could see an engine cease operation. This is caused by a rapid change in demand for air. With any increase in throttle, the air velocity at the spray bar is not feeding the required amount of fuel to speed up the engine. This situation is present on any throttle system that limits airflow and is dealt with in a number of ways.

NOTE

Rotec do not offer brackets, linkages or cabling. For linkages or cabling, online aircraft part stores can be helpful in sourcing the desired components.

If rapid throttle operation is required, throttle up from low idle RPM to a higher idle RPM, increasing the provision for rapid throttling.

NOTE

Maximum throttle control arm extension at Wide Open Throttle from Idle for the various models is as follows:

TBI-MKII	Idle Length	WOT Length	Extension
34 Series	169	206	37mm [1.46in]
40 Series	169	206	37mm [1.46in]
48 Model	182	227	45mm [1.77in]

Additional allowance must be made for engine movement on mounts to assure no interference with other parts of the engine or airframe components.

Following installation and hook up of the throttle linkage to the TBI throttle control arm, the cockpit mounted “open throttle” stop must be adjusted so that the cockpit throttle control contacts the stop concurrent with, or prior to, the slide reaching its full open position. This stop is required to prevent excessive pilot force being applied to the throttle control arm.

Adjustment of the “throttle closed” stop will be described in Mixture Setup (p.40) of this manual.

INSTALLATION: MIXTURE

MIXTURE CONTROL INTRODUCTION

The Mixture Control Arm on the TBI is a simple aluminium lever that can be positioned at different angles about the Spray Bar tube's axis. Full travel of the Mixture Control Arm requires that the arm be able to swing 90 degrees of arc in going from Full Rich to Full Lean as seen in Figure # 10 . The Full Rich mixture position occurs when the metering holes in the Spray Bar are orientated perpendicular to the airflow. Full Lean occurs when the metering holes look directly into the airflow.

The Mixture Arm Base is permanently pinned in place limiting the tube rotation angle to 90 degrees to ensure these settings. To avoid excessive overhang moments, the control element connected to the mixture arm must be a lightweight bowden wire or the equivalent. For installation flexibility, the Mixture Arm Lever may be orientated at any angle that does not obstruct the Throttle Control Rod for compatibility with the engine it is being installed in.

MIXTURE CONTROL SETUP

The Rotec TBI Fuel System has the most efficient means of adjusting fuel mixture. Rather that using a crude flow valve, it uses a fuel delivery spray bar with many tiny holes along its length, rotating through a smooth and consistent 90° arc.

Mixture	Full Lean	Maximum Rich
Turn Mixture Arm:	Clockwise	Counter Clockwise
Spray Bar Hole Orientation to Airflow:	Parallel*	Perpendicular

NOTE

***Spray bar holes face the incoming air stream. If the orientation were reversed, the spray bar would have no way of leaning the mixture.**

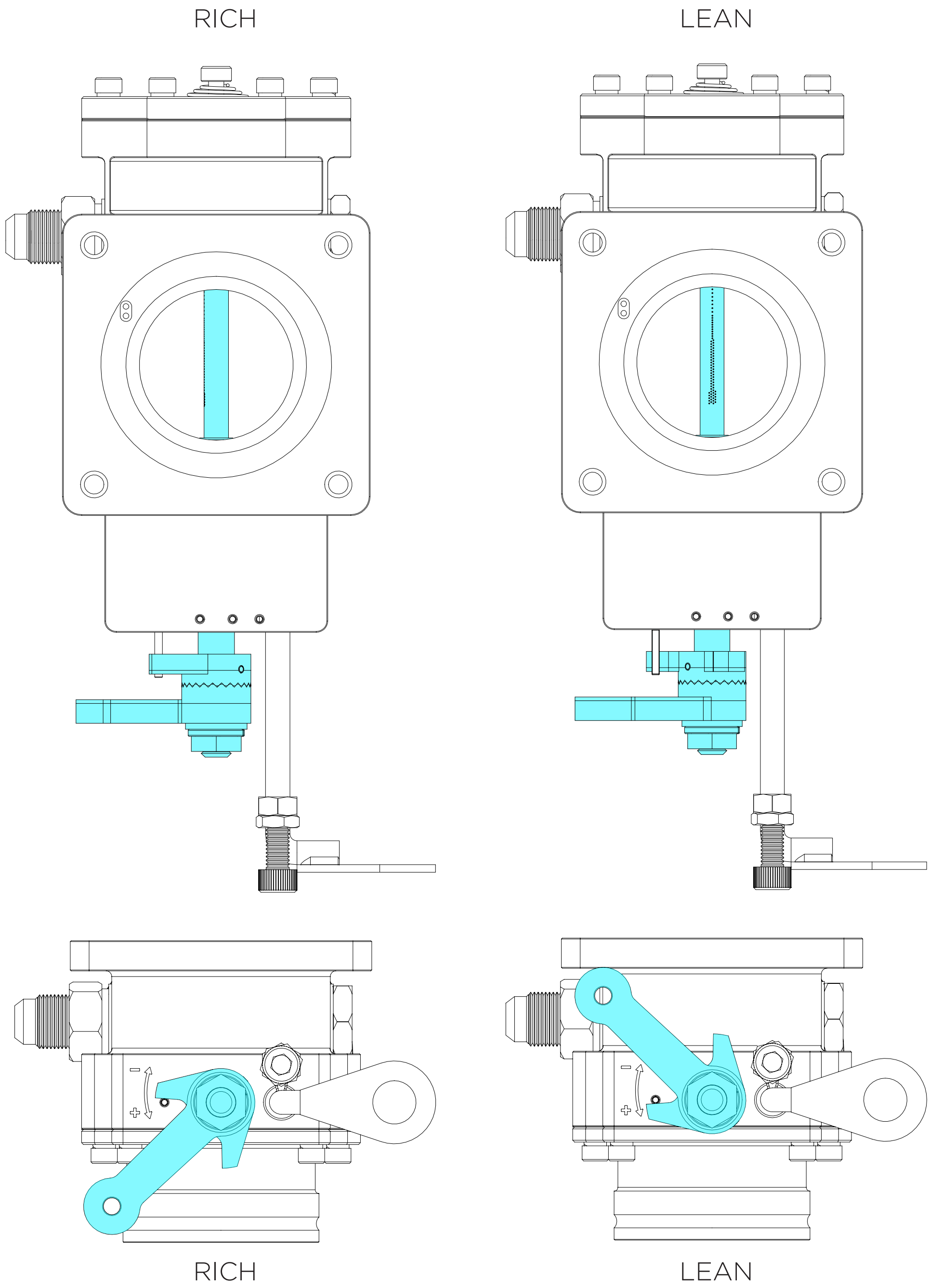


Figure # 10
Mixture Operation

MIXTURE ARM ADJUSTMENT

The mixture arm position can be adjusted for better access by the cockpit controls. To make an adjustment, undo the M8 lock nut with a 13mm wrench an adjust accordingly.

Be careful not to orientate the mixture arm with respect to the throttle control rod, so that it does not interfere with the throttle control rod stop. It is possible to have the arm prevent the throttle slide fully closing. This must be avoided.

COCKPIT CONTROL

Up to 3 bowden cables are required to control the throttle slide, mixture arm and primer from cockpit.

The mixture lever arm can be re-positioned on the mixture arm base ratchet. To do this loosen the M8 lock nut with a 13mm wrench and reposition as desired.

WARNING

Do not hang heavy unsupported cables on the mixture arm, as this can result in the damage to the mixture lever or base of the spray bar.

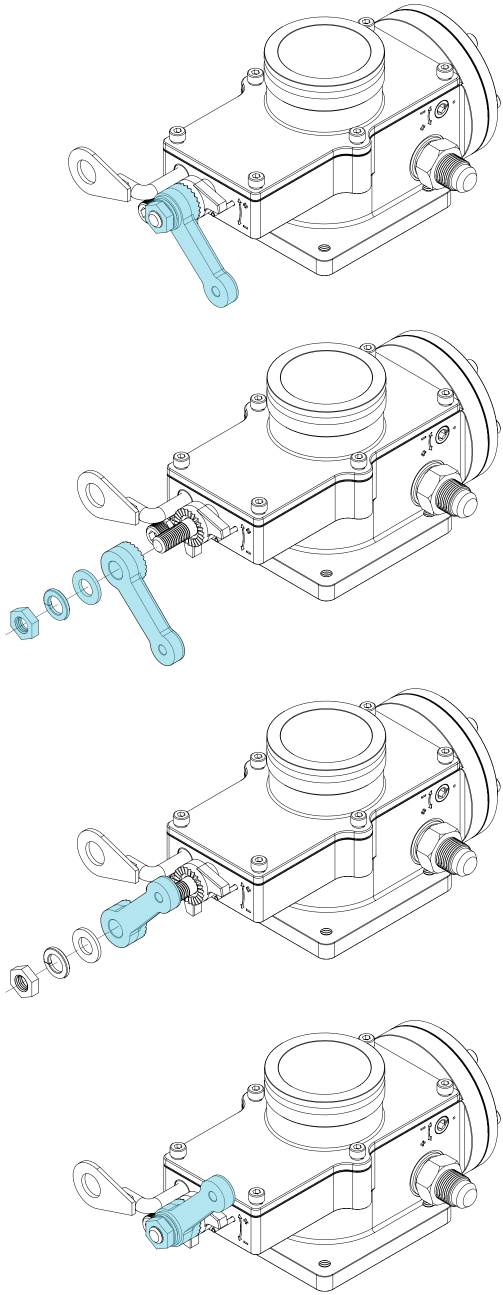


Figure # 11

INSTALLATION: PRIMER

REGULATOR OVERRIDE SETUP

The Rotec TBI Fuel System offers priming, a unique feature not found on the other fuel systems. When pressed, the function of the regulator is temporarily over ridden and fuel flows freely from the spray bar for engine cold starting.

The inclusion of a cockpit controlled primer lever is mandatory in the unlikely encounter of vapour lock or other possible fuel starvation anomaly. The primer can be used to recover a failed engine.

Located in the center of the fuel pressure regulator the primer button can be controlled from the cockpit via a push or pull slide cable, much the same as the mixture arm or throttle cable. Support brackets can be fabricated using sheet aluminium, a simple task for recreational aircraft users.

> **NOTE**
>
> **Use on-line aircraft part stores for sourcing desired linkages, cabling and throttles. We do not supply these, as customer requirements differ vastly between projects.**

CONFIGURATIONS

The primer can be activated using a pushing or pulling action, depending on how you choose to set it up.. This could even involve a mechanism where the mixture level position beyond full rich is used for primer control. The primer can be activated using a pulling action, allowing the use of a friction throttle for control. See the MK.I examples below where the regulator is separate entity to the body.

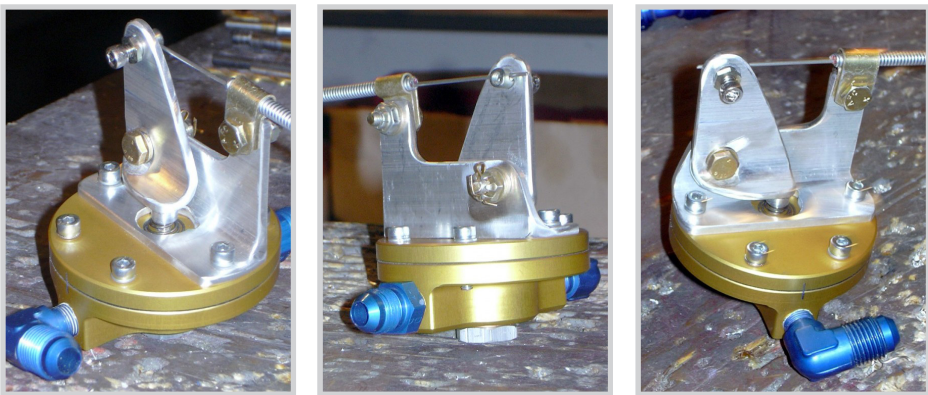


Figure # 12

Figure # 13

Example of custom made bracket design

ELECTRONIC CONTROL

While a regulator primer button activated by electronic control has been done, it is not ideal. In order to counteract vapour lock or other fuel starvation anomalies, such as air bubbles in the fuel lines, rapid pressing or continual depression may be required. Simple electronic control does not allow this, where manual control does. Furthermore, an electronic solenoid used to engage the TBI primer system could be prone to failure. A simple mechanical lever, operated by a cable, is less complicated and more reliable due to the absence of any electronics or electrical systems.

INSTALLATION: HEAT

PROTECTION FROM ENGINE HEAT

Air temperatures in the engine compartment downstream of the cylinders are usually about the same as the engine's oil temperature. Fuel system components such as filters, gascolators, boost pumps etc, can easily heat the fuel to its boiling temperature when located in this high temperature environment. While float carburetors separate vapour and discharge it through the float bowl vent, the TBI, like other diaphragm controlled fuel metering devices, pass this vapour on to the engine, resulting in roughness, power loss or power instability.

Vapor problems can be avoided by:

1. Locating filters, gascolators and boost pumps outside of the engine compartment,

2. Insulating engine compartment fuel line with fire sleeve

3. Blast cooling the engine driven fuel pump. If it is not possible to mount these components remotely, then they should be enclosed together in a box or shroud and blast cooled.

CARBURETTOR HEAT

A carburettor heat system is recommended when using the Rotec TBI fuel system. Although some customers choose not to install one to simplify their installation. Any carburettor or throttle body that restricts manifold pressure to control power output will by nature greatly reduce the local temperature at its throttle opening. Therefore the slide throttle can potentially be impeded from ice build up,if no carburettor heat system is present.

Inclusion of a carburettor heat system is at the discretion of the user.

Carburettor heat system can be used on demand or constantly depending on the desired setup.

INSTALLATION: AIR

INDUCTION AIR INLET

Fuel metering in the Rotec Throttle Body Injector is accomplished by sensing both the direction and velocity of air flowing past the spray bar tube. This means that engine performance can be adversely affected if air entering the Throttle Body Injector is extremely turbulent or is delivered from only one side of the inlet bell mouth.

In general, the efficiency of the induction air inlet can be judged by engine smoothness at full throttle and the extent to which the engine can be leaned at cruise power. An inlet with good flow characteristics will allow an engine equipped with a fixed pitch propeller to run smoothly with the mixture leaned 200 RPM below peak power when operating at or below 75% power. An engine equipped with a constant speed propeller should demonstrate smooth operation when leaned to peak exhaust gas temperature while operating at or below 75% power.

CAUTION

Severe engine damage can result from operation above 75% power with an excessively lean mixture. At a pressure altitude of 7000 feet, the engine produces only about 75% power at full throttle and can tolerate leaner mixtures. Consult the engine manufacturer's operating manual for proper leaning procedures for fuel injected engines.

Engines operating with poorly designed air inlets may demonstrate engine roughness at wide open throttle, inability to tolerate lean mixtures, and substantial variation in cylinder to cylinder head temperature or exhaust gas temperature.

Appendix D illustrates examples of good and bad inlet configurations. Good inlet configurations promote good cylinder to cylinder fuel distribution, because air enters the Throttle Body Injector inlet uniformly from 360 degrees around the inlet centerline.

Bad inlet configurations such as the examples shown in Appendix D, require intake air to undergo a sharp 90 degree bend while entering the Throttle Body Injector, causing some of the metered fuel to be deflected against the throat wall. Full throttle operation will be rough due to poor fuel distribution, and the engine will have little tolerance for operation on lean mixtures at cruise power settings.

Some configurations which do allow 360 degree air delivery like the one shown in Appendix D, may experience problems at full throttle due to the short vertical distance between the Throttle Body injector and the opposite air filter flange.

This configuration promotes the formation of a standing vortex in the inlet bell mouth, reducing the airflow capacity of the Throttle Body Injector with resulting full throttle roughness and loss of power.

The performance of engines with bending inlet flow-paths can be improved by increasing the bend radius or by providing a straight section of duct between the Throttle Body Injector and the bend. Alternatively, a 90 degree change in airflow direction can be accommodated by feeding the Throttle Body Injector from a relatively large volume plenum chamber as shown in Appendix D. Dimensions shown in these illustrations should be considered as the minimum. Increasing any of the dimensions will result in improved fuel distribution.

If a Throttle Body Injector is to be installed utilizing intake ducting from an earlier carburetor installation, ground tests should be conducted to determine whether any performance deficiencies exist. If any adverse symptoms are noted, the information contained herein should be used as the basis for designing a new inlet configuration.

AIR SUPPLY

The Rotec TBI Fuel Syetem relies on fine air filtration, as unwanted debris and dirt are not only bad for your engine, but also can impede the movement of the slide throttle. Such debris can accidentally be introduced when using sealant, compounds or tapes.

Depending on the users installation requirements, air cleaners/filters or plenum boxes can be easily attached to the TBI. Many users choose to fabricate a simple spigot from fiber glass. Others choose to fabricate a mount from aluminum or steel. There is no off the shelf industry standard mount for air cleaners/filter or a plenum box. All installations are unique.

NOTE

It is a good idea to make the internal diameter of the spigot flare match the full radius of the TBI trumpet. All TBI models come with the same air box flange, 4 x 1/4” UNC threads arranged in a 63.5mm (2.5”) square bolt pattern.

Check the external TBI dimensions, including the bolt pattern as the air cleaner/filter or plenum box must connect to here.

Large masses mounted to the TBI should be supported, especially for spigot type engine mounts as the rubber coupling could be pried off it if enough force is applied.

INSTALLATION: AIR

INDUCTION DESIGN

Good incoming air is critical for proper TBI performance. The following can negatively bias the airflow across the spray bar and have an adverse affect on performance:

- Scat hose or duct tubing with sharp bends

- Small air boxes or plenum's that supply inadequate air volume

A plenum box attached to a 30mm stand off works well. Plenum's act as a static air reservoir for the TBI to draw from, rather than pulling from a length of scat hose, which can often have dynamic air fluffing about its length.

If sharp bends are required as space is limited, you will need to use an air straightener or add a plenum chamber that the feed hose can attach to at any angle, even 90 degrees. The plenum in this instance serves as an air feeding chamber and the 90 degree feeder tube only has to replenish the plenum of air.

ISOLATION TEST

Try test running the engine without any induction system. If isolating the TBI from the induction system results in a change in performance, then a re-design of the air induction system will be required. The attachment of a well designed air induction system should cause no decrease in performance. See Appendix C for examples.

RAM AIR

Specific Ram air induction system should be avoided as the incoming ram pressure can disturbed the delicate pressure drop at the spray bar, if the pressure drop at the spray bar neutralized or even become positive then no fuel will flow, and at best the engine may become excessively lean in mixture.

WARNING

Ram air should be avoided as the increase in induction pressure can unsettle the delicate negative pressure across the spray tube. This could result in less than ideal engine performance and rough running. Ram Air becomes more powerful in flight so ground testing may not be a true indicator of total performance.

ENGINE PERFORMANCE

INITIAL ENGINE START

The initial engine start must be preceded by accomplishing the following check list:

1. The aircraft must be positioned with the cooling inlet facing into the prevailing wind, its tail securely tied and wheel chocks placed in front of the main wheels.

2. Verify that the aircraft has sufficient fuel. Turn the aircraft fuel valve ON.

3. Both magnetos **OFF.**

4. The idle mixture screw, located on the side of the TBI Main Body as well as the idle throttle stop screw have been set at the factory to a setting that should allow a successful first start. Either may be adjusted with an Allen wrench if the need for adjustment is indicated in later testing.

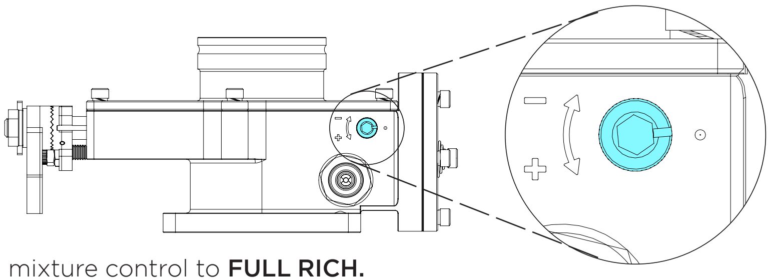


Figure # 14

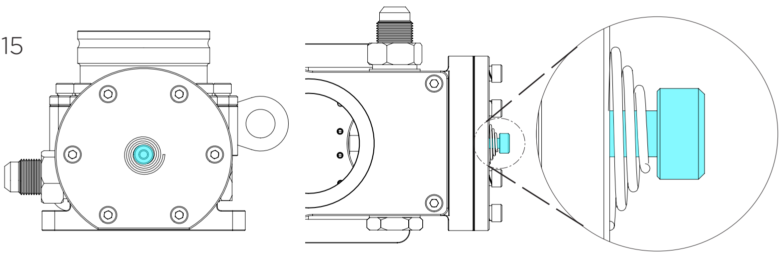
5. Set mixture control to **FULL RICH.**

6. Set throttle to 1/2 throttle opening.

7. Pressurize the fuel system by turning the electric fuel pump **ON** or by operation of the manual fuel pump.

8. With the fuel system pressurized and the throttle opened, press the Fuel Primer Button. This will open the fuel flow control valve in the regulator and cause fuel to flow out of the metering tube. Continue to press the button until fuel can be seen discharging from the metering tube.

Figure # 15



9. Engage the TBI primer to (should be operated from the cockpit) inject a given quantity of fuel for engine starting (experimentation will determine the best amount.

10. Set the throttle to a low position or just above idle. Around 1/8 to a 1/4 open.

NOTE

Note that once the TBI primer is engaged it may take several second for the air to be displaced from the dry fuel lines. It is normal to prime until raw fuel is seen dripping from the induction system or air cleaner.

11. With the magneto switches both in the **OFF** position, pull the propeller through 4 blades.

12. Place the magneto switches in whichever **ON** position is specified by the engine manufacturer for engine starting.

13. Engage the starter or begin manual propping.

14. If the engine does not start by the fifth compression stroke, return to step 10. If step 10 has been repeated three times or if symptoms of flooding occur, refer to Section 4, p.44 Unloading. Then return to step 11.

15. If the engine runs at a normal idle RPM and then dies after consuming the prime fuel, turn the idle mixture screw 1/2 turn counter clockwise and begin again at step 10.

16. If the engine runs at very low RPM and then dies, increase the idle throttle opening by rotating the idle throttle stop screw clockwise as necessary to obtain stable operation.

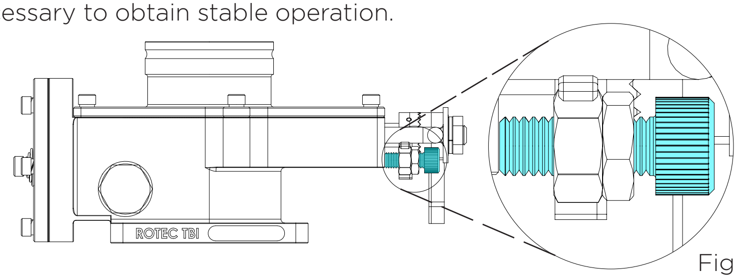


Figure # 16

NOTE

Fine tuning the idle adjustment is described in Section 3-4 and will be done after the engine has been thoroughly warmed up by operation at full power.

18. Both Magneto switches to **OFF** position at all times except when engine is being started or is running.

MIXTURE SETUP

MIXTURE OPERATION

Typically at all throttle positions, the mixture is set to the full rich position.

Unlike other fuel systems, the Rotec TBI Fuel System does not require mixture adjustment during flight if power settings or fuel tank levels change. For any given throttle position, the air ratio will be maintained. This ratio is set by the allocation of the many spray bar holes in relation to the power setting being used.

LEANING

Mixture can be leaned at cruise power settings during cross country flights where fuel economy is required. To do this:

1. Set throttle to 75%

2. Lean mixture to a point that allows smooth running

FULL LEAN

At high engine RPM, the full lean position will shut down the engine.

FULL RICH POSITION

In most case, the full rich position will not be hard against the maximum rich stop. The full rich mixture position will vary depending on elevation. To set the full rich position:

If EGT monitoring is available (Exhaust Gas Temperature)

1. Run engine at WOT
2. Adjust mixture to find peak EGT (technically stoichiometric)
3. Richen mixture to a point resulting in a 27°C (80°F) drop from peak EGT
4. Record this mixture position as full rich

If EGT monitoring is not available (Exhaust Gas Temperature)

1. Run engine at WOT
2. Set mixture to maximum rich stop
3. Lean from maximum rich stop until peak RPM is reached
4. Slowly richen mixture until RPM starts to drop
5. Record this mixture position as full rich

FULL RICH ADJUSTMENT

The following procedure should be carried out with all inlet ducting removed. Because the engine will be operated at full open throttle, a piece of 1/16 " mesh screen should be secured over the bellmouth to prevent the ingestion of foreign debris.

1. The aircraft must have its tail tied down and wheel chocks must be in-place.

2. Start the engine and run at low power and full rich mixture until the engine is properly warmed.

3. Run the engine briefly at full throttle and adjust the mixture control to yield an exhaust gas temperature 90 degrees Celsius on the rich side of peak temperature. If exhaust gas temperature instrumentation is not available, and if the engine is equipped with a fixed pitch propeller, adjust the mixture so that engine speed is reduced 50 RPM on the rich side of its peak value. If a constant speed propeller is installed, adjust the fuel flow to the value specified by the engine manufacturer for the RPM and manifold pressure observed at wide open throttle with the propeller governor set to yield the engines maximum speed.

4. While the mixture control remains fixed in the position established in step 3, return the throttle to idle.

5. After sufficient cool down at idle, kill the engine by turning the magneto or ignition switch to **OFF.**

6. With the engine off, install a full rich mixture stop in the TBI mixture linkage to limit full rich mixture travel to the position established in step 3 above. This stop is usually most conveniently installed as a stop pin inserted into the cockpit throttle quadrant. If a push/pull cable is used for the mixture control, a slit bushing of appropriate length can be installed over the push rod between the mixture control nob and the instrument panel.

7. Install the air filter and all inlet ducting, repeat steps 1 and 2, then run the engine briefly at full throttle. Confirm the setting established in step 3, and make additional adjustment if required. If roughness occurs at full throttle with all inlet ducting in place, then excessive inlet turbulence is indicated. Consult Appendix C (p.78) regarding inlet duct design.

ENGINE PERFORMANCE MIXTURE SETUP

MAXIMUM THROTTLE ADJUSTMENT

Because the Rotec TBI may be installed on a wide range of engine sizes, it may be necessary to set a maximum throttle opening stop, to limit the amount the TBI throttle slide can be opened. To determine the optimum (WOT) throttle opening, a manifold pressure gauge will be required. To test, increase the throttle opening for maximum power and monitor both engine RPM and manifold pressure (MP). As soon as the RPM peaks take note of the MP. These should be peaking at the same time, ie peak MP should result in peak power and RPM.

From this point there would be no need to increase the throttle any further as doing so will not result in a greater power as peak MP has already been reached. In fact further opening of the throttle will cause a reduction of airspeed and cause an unwanted leaning of the TBI and erratic full throttle behavior.

The following steps should be followed only if it is determined that the engine runs rough, loses power, or is excessively lean at the full throttle position.

1. Secure the aircraft with tie-downs and wheel chocks.

2. If an absolute pressure manifold pressure gauge is installed, note the reading that occurs prior to engine start. If a manifold vacuum gauge is installed, confirm that the gauge reads “zero” prior to engine start.

3. Start the engine and run at low power until the engine is properly warmed.

4. While the throttle is locked in the position established in step 3 above, adjust the mixture control to provide peak RPM.

5. With the mixture control secured in the peak RPM position, confirm that the manifold pressure or vacuum gauge reading is unchanged from Step 4.

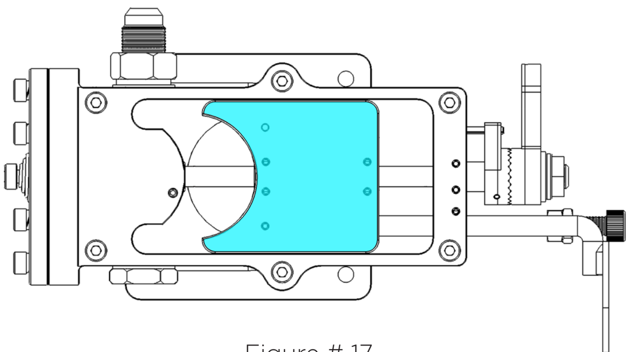


Figure # 17

6. Mark, measure, or otherwise note the throttle position so that this position can be reset following engine shutdown.

7. Return the throttle to idle.

8. After sufficient cool down, kill the engine by turning off the ignition.

9. Adjust the open throttle stop on the throttle quadrant limiting the maximum slide opening.

10. Start the engine and confirm that the throttle stop limits the throttle opening as specified in step 4.

Any reluctance of the engine to run smoothly at full throttle is likely due to excessive throttle opening or poor inlet air duct geometry. See Appendix C (p. 78) for example inlet designs.

IDLE SETUP

IDLE SPEED (RPM)

The idle speed is set using the idle stop, located on the throttle slide arm.

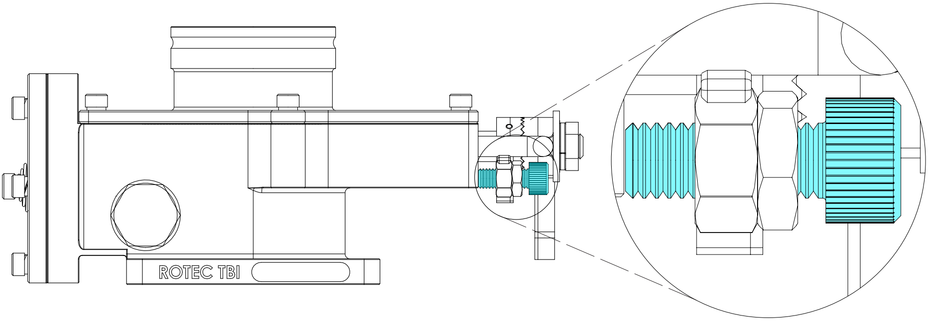


Figure # 18

The further the throttle stop is screwed in, the greater the throttle opening and idle rpm will be when the throttle is fully closed as the engine is idling.

Tighten the jam nut on the idle stop to hold it in the desired position. You may wish to loctite the idle stop into place when the desired setting has been established.

IDLE MIXTURE

Put simply, the idle circuit is a 2mm (0.08”) hole that supplies a small amount of fuel at idle, independent from the main mixture arm setting. The idle mixture screw is used to set the idle mixture. It is located on the edge of the TBI housing.

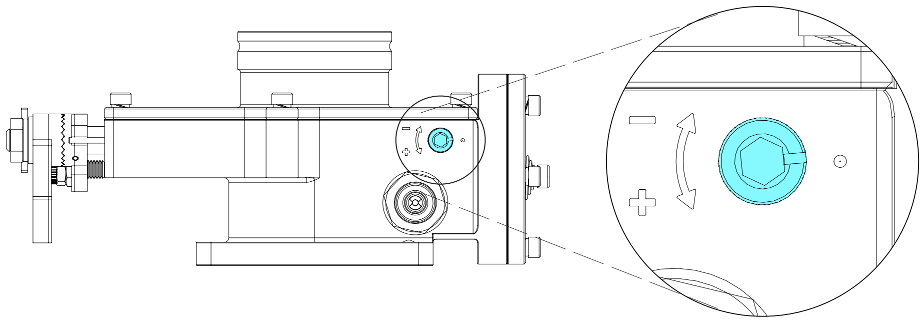


Figure # 19

A new unit is factory set at approximately a 1 + 3/4 turn out from fully closed. The M5 socket head cap screw controls idle fuel flow to the 2mm idle jet. Use a 4mm hex key to adjust to desired position.

NOTE
The idle jet is a separate jet to the spray.

Desired effect to idle mixture	Lean	Rich
Turn Idle mixture screw	Clockwise (in)	Counter Clockwise (out)

To richen the idle mixture, unscrew the idle screw a 1/4 turn at a time. The screw will need a total of approximately 3/4 to 2 turns, no more than 3 turns from the fully closed position should be required.

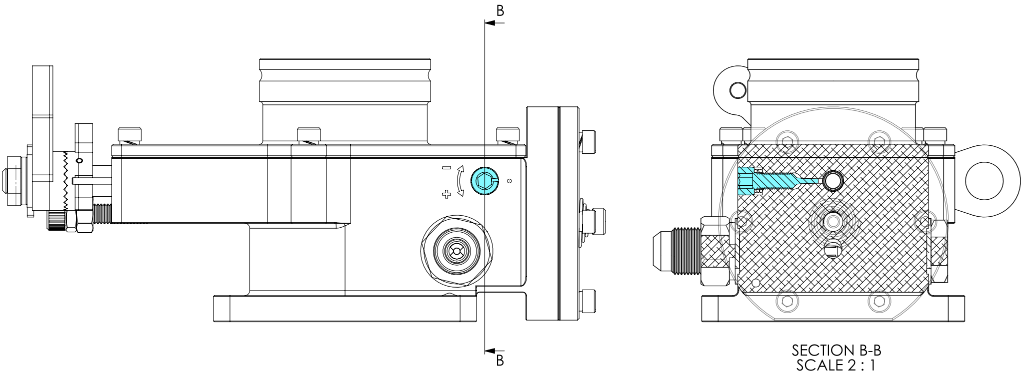


Figure # 20

WARNING
Be careful not to over tighten the idle mixture screw or it can damage the idle jet taper seal. To seat the idle mixture screw, turn the screw carefully and feel for when the needle seats into the idle mixture hole, do not tighten it further than this.

In a safe environment, set the idle while the engine is running. If this is not possible, then make small 1/4'' turn adjustments between engine shutdowns.

For optimum settings, keep the mixture slightly rich. The idle mixture screw has no effect on the main mixture.

ENGINE PERFORMANCE IDLE SETUP

IDLE ADJUSTMENT

The following procedure requires that the cockpit mixture control be placed in the full rich position, and that the engine has reached its operating temperature ie. (Warmed up).

1. Start the engine and set the throttle to the desired idle RPM.

2. If the engine is running with excessive richness or leanness, correct by adjusting the idle mixture screw. Clockwise rotation to lean and counter clockwise to enrich.

3. Adjust the idle throttle stop screw as necessary to get desired idle RPM.

4. Adjust the idle mixture screw to give peak RPM; then enrich to decrease speed by 25 to 50 RPM.

5. If idle RPM is different than desired, return to step 2. Several iterations through steps 2 through 4 may be required.

6. Following completion of the above, the engine should run at the desired RPM with the mixture control in the full rich positions. Movement of the mixture control to the full lean position should cause the engine to increase its speed 25 to 50 RPM before decreasing.

7. Accelerate the engine from 1000 RPM to full power by sudden throttle movement to wide open. If the engine stumbles, hesitates or stalls, then en-richening the idle mixture circuit will help.

8. Operate the engine at full throttle and exercise the mixture control to confirm that full rich operation is 50 RPM or 90 degrees Celsius. EGT on the rich side of peak. If not, then repeat steps 3 through 6 of Maximum Throttle Adjustment, (p.40).

INSTALLATION COMPLETION

FINAL STEPS

Install all remaining induction system components.

INSTALLATION INSPECTION

After the TBI installation is completed in accordance with the preceding sections of this manual, it is recommended you should have the engine inspected by a person having technical expertise in aircraft fuel systems.

This independent second party inspection will minimize the chance of some unsafe condition remaining undetected. Following the visual inspection, the inspector should observe a ground run from idle to full static RPM, watching for fuel leaks, excessive exhaust smoke or any other indications of unusual engine behavior. Any discrepancies must be corrected prior to proceeding with the first flight (Section 5).

Following engine shutdown, inspect the engine, TBI, and all associated plumbing, linkage, and ducting for signs of chafing, interference or leakage.

Following completion of the above inspection, install the cowling and any other items necessary for final airworthiness.

Make appropriate entries in the aircraft log books and consult with the local flight authorities regarding any requirements they may have for revising the aircraft's operating limitations by installing an after market product.

STANDARD OPERATION:

OVERVIEW

This section outlines the procedures to be used in normal operation of the Rotec TBI after the unit has been installed and adjusted in accordance with the preceding sections of this manual. If any instruction or procedure specified in this section conflicts with recommendations of the aircraft or engine manufacturer, then those recommendations should take precedence over contrary instructions contained herein.

ENGINE STARTING:

CONVENTIONAL STARTING

The following starting procedure should be used for the engine's first start of the day and any time the engine has cooled to ambient temperature.

1. Turn both magnetos **OFF.**

2. Master switch **ON.**

3. Brakes **ON**, wheel chocks in place or tail tied down.

4. Mixture set to **Full Rich.**

5. Throttle cracked 1/8 inch.

6. Turn on Fuel Pump (if required)

7. Turn on ignition

8. Depress the regulator override for 5 seconds, priming the intake with fuel*

9. Magneto switches positioned as recommended by the engine manufacturer for engine starting.

10. Engage the starter or commence manual propping.

11. If the engine does not start by the fifth compression stroke, return to step five. If symptoms of flooding occur or step five has been repeated three times, then proceed to Unloading (p.50).

12. 12. Engine starts
    (a.) If engine does not start, hold the regulator primer button while activating the starter motor.
    (b.) Once the engine has been started, subsequent restarts should not require priming up to several hours later.

13. 13. When then engine starts, set the throttle to the desired RPM.

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 and then close throttle once priming is completed.**

HAND STARTING

WARNING

Hand propping an engine can be dangerous. Ensure all safety precautions are considered.

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 and magnetos.
6. Standing in front of the engine, throw the propeller from top to bottom CCW while stepping back in caution.
7. Engine starts.

WARNING

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

HOT STARTS

When the engine is warm, use the same procedure as for normal starts, except omit the use of prime fuel (step 6).

NOTE

Hot starts are sometimes more easily accomplished if the engine is shut down using the magneto switches rather than the mixture control.

UNLOADING:

If during starting attempts the engine becomes overloaded with fuel, the induction system may be cleared as follows:

1. Turn both magnetos **OFF.**
2. Set throttle slide to **FULL OPEN.**
3. Set mixture control to **FULL LEAN.**
4. Manually rotate the engine backwards through 20 blades.
5. Close the throttle, set the mixture at **FULL RICH** and initiate the appropriate starting procedure once again.

LEANING:

RUNNING LEAN OF PEAK (LOP)

Running lean of peak (LOP) saves fuel and prolongs engine life. Contrary to conventional wisdom, research has shown that lean of peak operation in the cruise (under 75% power) provides lower cylinder temps.

With a Bing carburettor installed LOP operation is not usually possible owing to inability to lean mixture in-flight.

IN-FLIGHT LEANING

The Rotec TBI greatly increases the engines tolerance for lean mixtures when compared to conventional aircraft carburetors. For this reason, the common practice of leaning to the threshold of engine roughness may allow leaner operation than previously achieved. If in doubt, follow the engine manufacturer's recommendations which rely on EGT, fuel flow, or RPM as a reference for leaning.

ACCIDENTAL LEAN CUT IN FLIGHT

If the mixture arm is leaned to the point where the engine quits during flight, do not set the mixture to full rich to bring the engine back to life.

If you lean the engine to the point where it has actually stopped firing during flight, richening the mixture will likely do nothing. Airspeed over the spray bar will have become too slow to help, even if you go to the full rich position.

The best way to bring the engine back to life is to promptly pull the throttle back to idle, (if the prop is still wind milling this will immediately restart the engine), then apply full rich, and increase power to desired levels.

The engine will give plenty of warning that it is getting towards an excessively lean state. It will start to run very roughly when too lean. Leaning any further will see the engine starve of fuel and stop it from running.

FLIGHT COMPLETION:

SHUTDOWN: IGNITION SYSTEM

Turn off the ignition system, stopping fuel from being ignited.

FUEL STARVATION

Depending on orientation, residual fuel from fuel lines may leak from the TBI after shutdown. This is unburned fuel left over when the engine is shut down via ignition. If this is of concern, the engine can be shut down by:

1. Ceasing fuel supply via fuel tap

2. Turning off the fuel pump

The engine will stop running as fuel in the fuel lines is depleted.

LEAN CUTTING

To lean cut the engine:

1. Set mixture to full lean

2. Raise the RPM until the idle mixture cannot maintain power

The engine will not likely lean cut when idling, as idle fuel comes from a separate jet. Leaning the mixture only rotates the spray bar. However, the throttle slide will have most if not all of the spray bar jets closed at idle.

ENGINE SHUTDOWN:

The engine may be shut down by any of the following:

1. Set the mixture control to **FULL LEAN.**

2. Set the main fuel valve to the **OFF** position.

3. Turn both magneto switches to the **OFF** position.

If procedures 1 or 2 are used, both magnetos must be turned to **OFF** after the engine has stopped.

It has been observed that hot re-starts are sometimes more easily accomplished following engine shutdowns using procedure 3.

It is good practice to occasionally kill the engine with the magneto switch to determine that both magneto grounding circuits are functioning properly. A switch malfunction or an “open” P-lead will permit one or both magnetos to remain “hot”, allowing the engine to continue running regardless of switch position.

CAUTION

Because of residual fuel that always remains in the fuel system, there is constant danger of the engine firing if the propeller is rotated.

The main fuel valve must always be placed in the **OFF** position whenever the aircraft is to be parked or hangared.

MAINTENANCE PROCEDURES:

MAINTENANCE & REPAIR:

The following maintenance should be accomplished at the intervals indicated:

1. Remove and clean or replace the aircraft main fuel system filter each 100 hours of engine operation.

2. Remove and clean the TBI fuel inlet finger screen each 100 hours of engine operation.

CAUTION

Do not use thread sealing compounds or tape. All fitting joints use either a ring seal or a flared tube seat and, if properly installed, require no additional sealing material.

NOTE

If contaminants are found inside the fuel inlet filter screen, the source must be found and corrected.

3. Clean the inlet air filter each 50 hours of engine operation or more frequently if operated in dusty conditions.

CAUTION

The ingestion of unfiltered air into the TBI can create hazardous throttle plate binding and slide seal wear.

4. After an initial period of five hours of operation, idle mixture should be checked and readjusted as needed.

SERVICE & OVERHAUL:

After hundreds of hours of use, the Rotec TBI Fuel System may require overhaul. Service intervals vary depending on the size of the engine, fuel type used and control setup.

If you wish to conduct overhaul yourself, TBI Overhaul Kits are available to purchase from Rotec Aerosport. Kits include the following replacement parts:

- Slide Seals
- Star Clips
- Roll Pins
- Regulator Diaphragm Assembly

WARNING

Workmanship or modifications carried out by entities not employed by Rotec are not covered by warranty. Damage of components is at the risk of the individual. Alternatively, workmanship can be conducted by Rotec to avoid accidental damage.

PRECAUTIONS:

INDUCTION ICE

Field data has indicated that **the Rotec TBI is likely to create carb ice.** However, engines with cold induction manifolds such as the four cylinder Continental engines, the Continental O-470, and all Volkswagen derivative engines, are susceptible to the formation of manifold ice. At idle power, icing is indicated by erratic RPM (loping after a smooth idle) or other signs of richness. This condition can be corrected with the application of induction heat. In cruise, Icing might be indicated by a gradual enrichment of mixture, or the inability to lean the engine with the mixture control. This condition can be corrected by selecting full rich mixture and applying induction heat. Additionally, ice built up during cruise can sometimes be removed by cycling the throttle from full open to full closed and then back to the desired setting.

VAPOUR LOCK/FUEL STARVATION

VAPOUR LOCK PREVENTION

- Vapour lock is more prevalent when using automotive gas (Mogas) instead of Avgas. Using Avgas will lower the chance of experiencing vapour lock.

- All fuel related items such as fuel pumps, fuel lines and the TBI regulator should be kept as cool as possible. Air flow past these items is recommended.

- If necessary include a T-fitting on the inlet side of the regulator with a return line back to the fuel tank. If the fuel pump is continually circulating fuel, although it is not being used by the TBI, as it is limited by the regulator (for example, when the engine is idling), any vapour (air bubbles) that develop in the fuel lines will have the ability to escape to the fuel tank. This constant flow also cools the fuel pump. The fuel tank return line will require a restrictor in series (approximately 1.5mm (1/16”) hole). The restrictor will ensure fuel is supplied to the regulator at all times as required, while allowing air bubbles to escape.

OVERCOMING VAPOUR LOCK OR FUEL STARVATION

If vapour lock or failure of the fuel delivery system is suspected, introduce fuel by pressing the regulator primer button. By holding or repeatedly pressing the primer, fuel can flow freely through the regulator and quickly flush away any vapour lock built up in the fuel lines. Manual priming should be kept in mind in the unlikely event of an emergency situation such as an engine stopping in flight.

Tests have shown at full power most engines will continue to run when extremely rich, even when the regulator primer button is employed

HIGH ALTITUDE TAKEOFF

When operating out of high altitude airports, takeoff power should be optimised with the manual mixture control in accordance with the aircraft or engine manufacturer's recommendations.

HOT WEATHER OPERATION

When operating in conditions of very hot ambient air temperatures with very tightly cowled engine installations, fuel vapour formation may occur causing engine roughness. This problem can usually be solved by:

1. Careful thermal insulation of all fuel lines and fuel system.

2. Air blast cooling of fuel pumps and other fuel components.

3. Installation of thermal shields to protect fuel system components from radiant heating by exhaust system.

4. Turn boost pump **ON.**

FIRST FLIGHT:

GENERAL

The first flight must not be attempted unless every detail of the installation has been accomplished in strict compliance with this manual and the pilot is thoroughly familiar with the standard operating procedures as defined in the standard operations chapter (page 48).

> **CAUTION**
>
> **If any procedure specified in this section conflicts with recommendations of the aircraft or engine manufacturer, then those recommendations should take precedence over contrary instructions contained herein.**

During the first flight the pilot should have available a pencil and the flight test log sheet included as Appendix B in this manual for recording flight test data.

> **CAUTION**
>
> **If at any time during the following procedures the engine or flight instruments give readings that are outside of acceptable limits, the flight should be discontinued.**

1. Pre-flight the aircraft in accordance with normal pre-flight procedures.

2. Start the engine in accordance with the standard operations procedure (p. 48) of this manual.

3. Complete the normal engine run up and pre-take-off check lists. Prior to brake release, check engine instruments to determine that full take-off power is available. The take-off should be accomplished with the mixture in the full rich position and the induction heat off.

4. Climb to an altitude that is comfortable for normal cruising flight and reduce throttle to cruise power. After trimming the aircraft for hands-off level flight, allow enough time for the aircraft's speed to stabilize, then record the data requested on line 1 of the flight test log.

5. While at the same altitude and power setting as above, carefully lean the mixture to peak RPM or peak EGT if a constant speed propeller is installed. If RPM or EGT begins decreasing as the mixture is leaned, then the full rich mixture setting is too lean. Discontinue the flight and repeat section 3-3 of this manual. After 5 minutes of hands-off stabilized level flight, record the data requested on line 2.

6. While at the same altitude and power setting, slowly lean the mixture to the threshold of engine roughness. Record on line A the RPM (or EGT) at which roughness is first noticed and then return the mixture to full rich.

7. While at the same altitude as above, advance the throttle to wide open. Adjust mixture to 50 RPM (50 degrees EGT) on the rich side of peak, Trim the aircraft and allow time for the aircraft speed to stabilize. Record data required on line 3.

8. Climb to 7000 feet leaving the mixture control set as directed in step 7 above. Trim for hands-off level flight at full throttle, and allow time for speed to stabilize. Record data on line 4.

9. While at the same stabilized flight condition, lean mixture to peak RPM (EGT). Record data on line 5.

10. At the same stabilized flight condition, lean the mixture to the threshold of engine roughness. Record the RPM (EGT) at which this occurs and then enrich only as necessary, just to restore smooth operation. Record data requested on line 6.

11. Position mixture control to FULL RICH prior to descent.

12. After landing retard the throttle to idle while mixture is full rich. Record idle RPM on line B.

13. With brakes on, and tail tied down, set the engine speed at 1000 RPM and perform a “jam” acceleration. Note behavior on line C of the test flight log.

Following completion of the above test, fill out all remaining portions of the flight test log sheet. The original should remain with the aircraft log book and a copy can be sent to Rotec Aerosport for our database.

APPENDICES:

APPENDIX A:

FLIGHT TEST LOG SHEETS

PRE-INSTALLATION CALIBRATION OF ORIGINAL FUEL METERING SYSTEM

Date:	
Aircraft Weight:	
Type of Original Fuel Metering System:	

	ALT	OAT	RPM	IAS	Man Press.	Fuel Flow	Oil Temp	EGT
1.								
2.								
3.								
4.	7000							
5.	7000							
6.	7000							

A. Record RPM at which engine roughness occurs:

Step 6	RPM
Step 10	RPM

B. Describe acceleration behavior observed in step 12:

APPENDIX A:

POST-INSTALLATION CALIBRATION OF ROTEC THROTTLE BODY INJECTOR

Date:	
Aircraft Weight:	
TBI Model:	
Serial Number:	

	ALT	OAT	RPM	IAS	Man Press.	Fuel Flow	Oil Temp	EGT
1.								
2.								
3.								
4.	7000							
5.	7000							
6.	7000							

A. Record RPM at which engine roughness occurs:

Step 6	RPM
Step 10	RPM

B. Describe acceleration behavior observed in step 12:

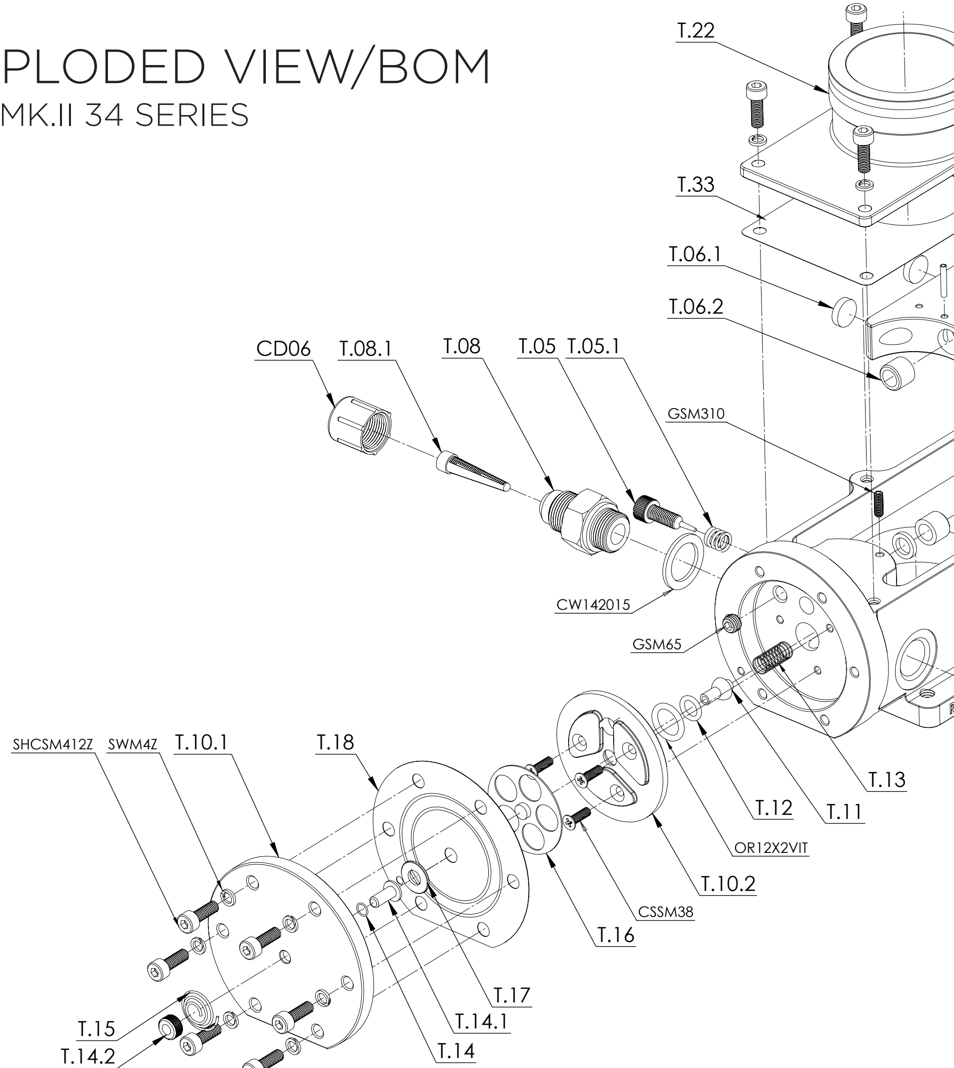
C. Describe the installation:

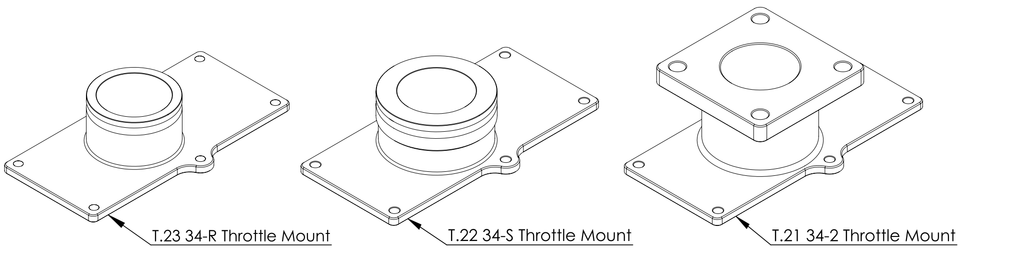
Aircraft Type:	
Aircraft Number:	
Builder's Name:	
Engine Model:	
Propeller:	
Fuel Pump type:	
Engine time-TT:	
Engine SMOH:	
Installation includes:	( ) Induction heat ( ) Electric Fuel Boost Pump ( ) Gravity Feed Fuel System ( ) Updraft Installation ( ) Air Filter ( ) Manual Boost Pump ( ) Engine Primer ( ) Horizontal Installation

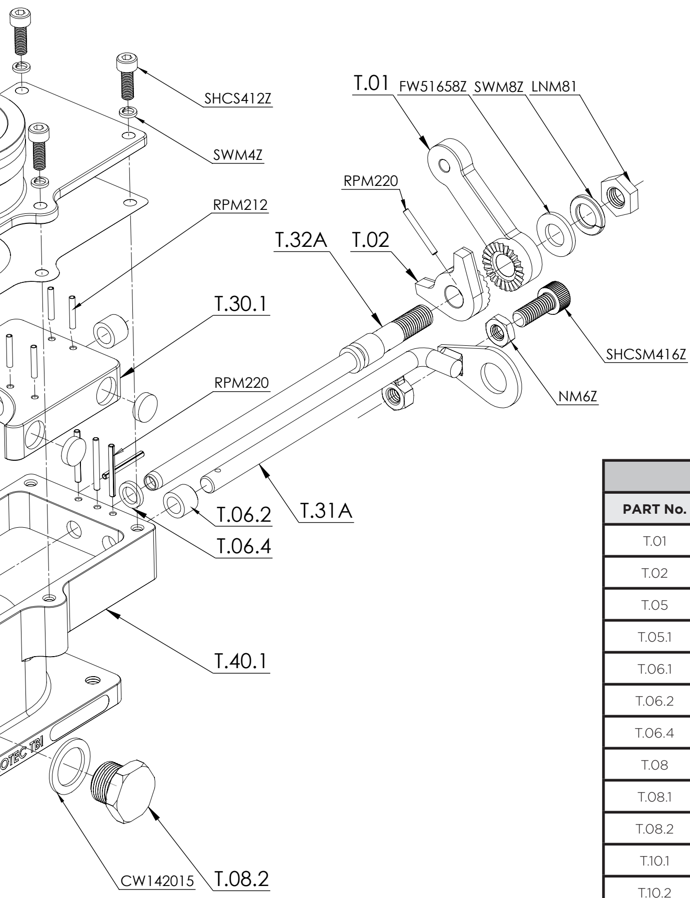
APPENDIX B:

EXPLODED VIEW/BOM

TBI-MK.II 34 SERIES







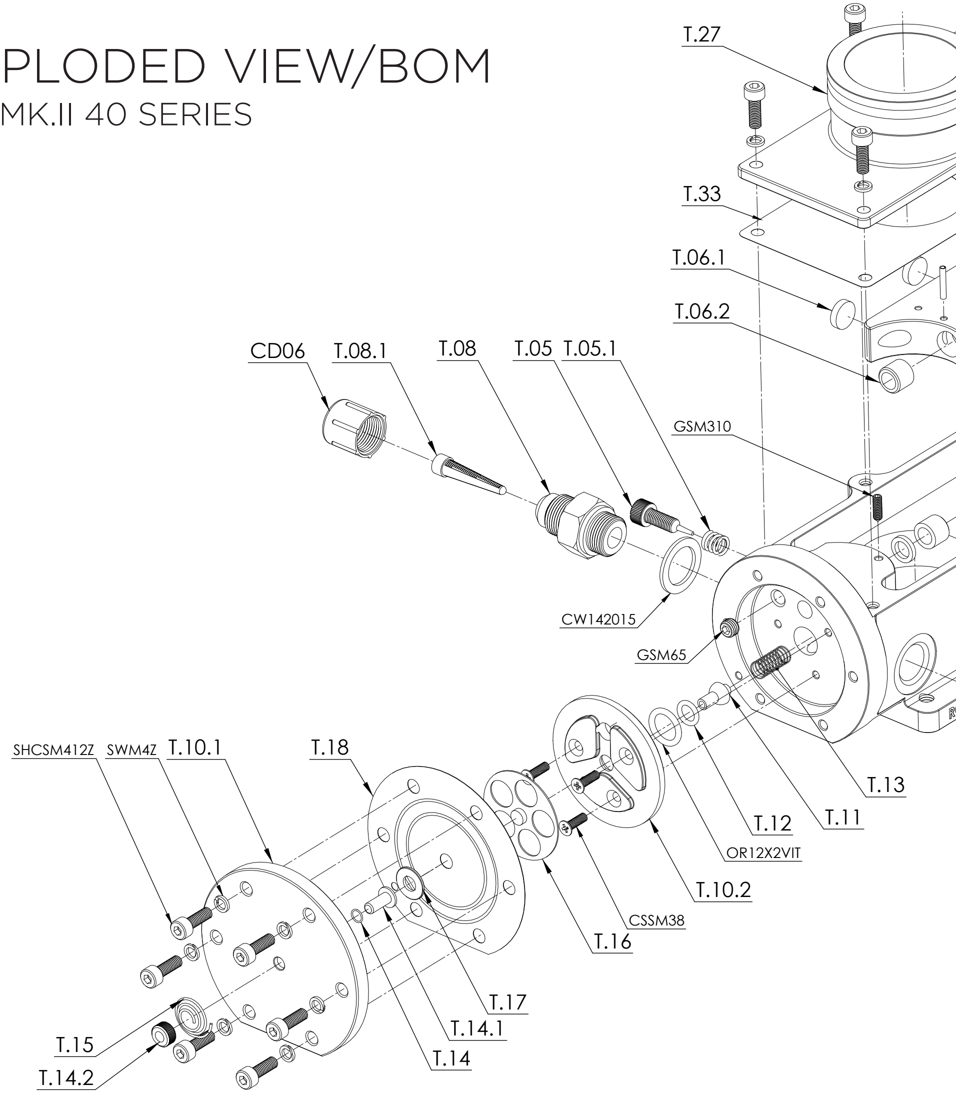
FASTENERS LIST		
PART No.	**DESCRIPTION**	**QTY.**
CSSM38	Counter Sunk Screw M3	3
CW142015	Copper Washer 14 x 20	2
FW51658Z	Flat Washer M8	1
GSM65	Grub Screw M6 x 5	1
GSM310	Grub Screw M3 x 10	1
LNM81	Hexagon Nut M8	1
NM6Z	Hex Jam Nut M6	1
OR12X2VIT	Retaining Disk O-Ring	1
RPM212	Roll Pin M2 x 12	5
RPM220	Roll Pin M2 x 20	5
SHCSM412Z	Socket Head Cap Screw	12
SHCSM416Z	Throttle Stop Screw	1
SWM4Z	Spring Washer	12
SWM8Z	Lock Washer	1

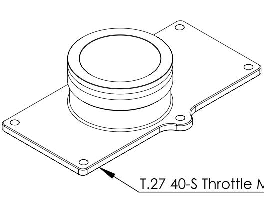
ROTEC TBI COMPONENTS		
PART No.	**DESCRIPTION**	**QTY.**
T.01	Mixture Arm Lever	1
T.02	Mixture Arm Boss	1
T.05	Idle Mixture Screw	1
T.05.1	Idle Screw Spring	1
T.06.1	Throttle Slide Pad	4
T.06.2	Rod Bush	4
T.06.4	Quad Ring	2
T.08	Fuel Fitting	1
T.08.1	'Last Chance' Fuel Filter	1
T.08.2	Fuel Plug	1
T.10.1	34-40 Regulator Cover	1
T.10.2	Regulator Valve Retainer	1
T.11	Regulator Flow Valve	1
T.12	1/4'' O-Ring	1
T.13	Flow Valve Spring	1
T.14	Primer Button O-Ring	1
T.14.1	Regulator Override Shaft	1
T.14.2	Override Primer Button	1
T.15	Regulator Override Spring	1
T.16	Diaphragm Retaining Disk	1
T.17	Diaphragm Rivet Washer	1
T.18	Regulator Diaphragm	1
T.22	30-S Throttle Mount	1
T.30.1	34-40 Throttle Slide	1
T.31A	34-40 Throttle Control Rod Assembled	1
T.32A	34-40 Spray Bar Weldment	1
T.33	34-40 Teflon Gasket	1
T.40.1	34 Housing	1
CD06	Cap Plug	1

APPENDIX B:

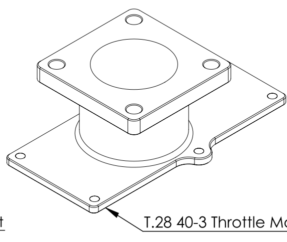
EXPLODED VIEW/BOM

TBI-MK.II 40 SERIES

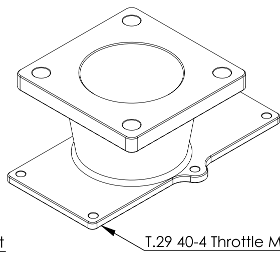




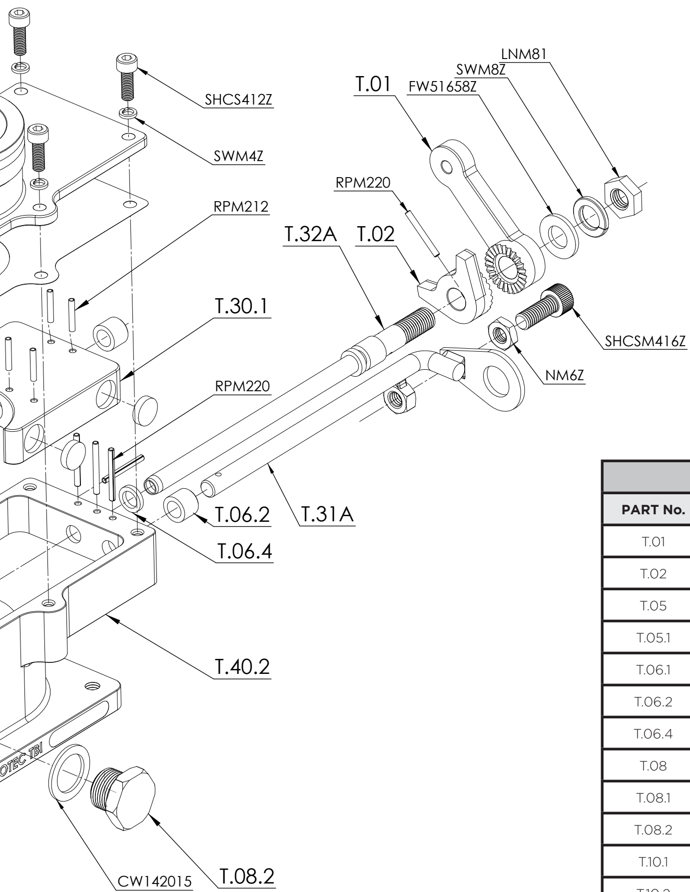
T.27 40-S Throttle Mount



T.28 40-3 Throttle Mount



T.29 40-4 Throttle Mount



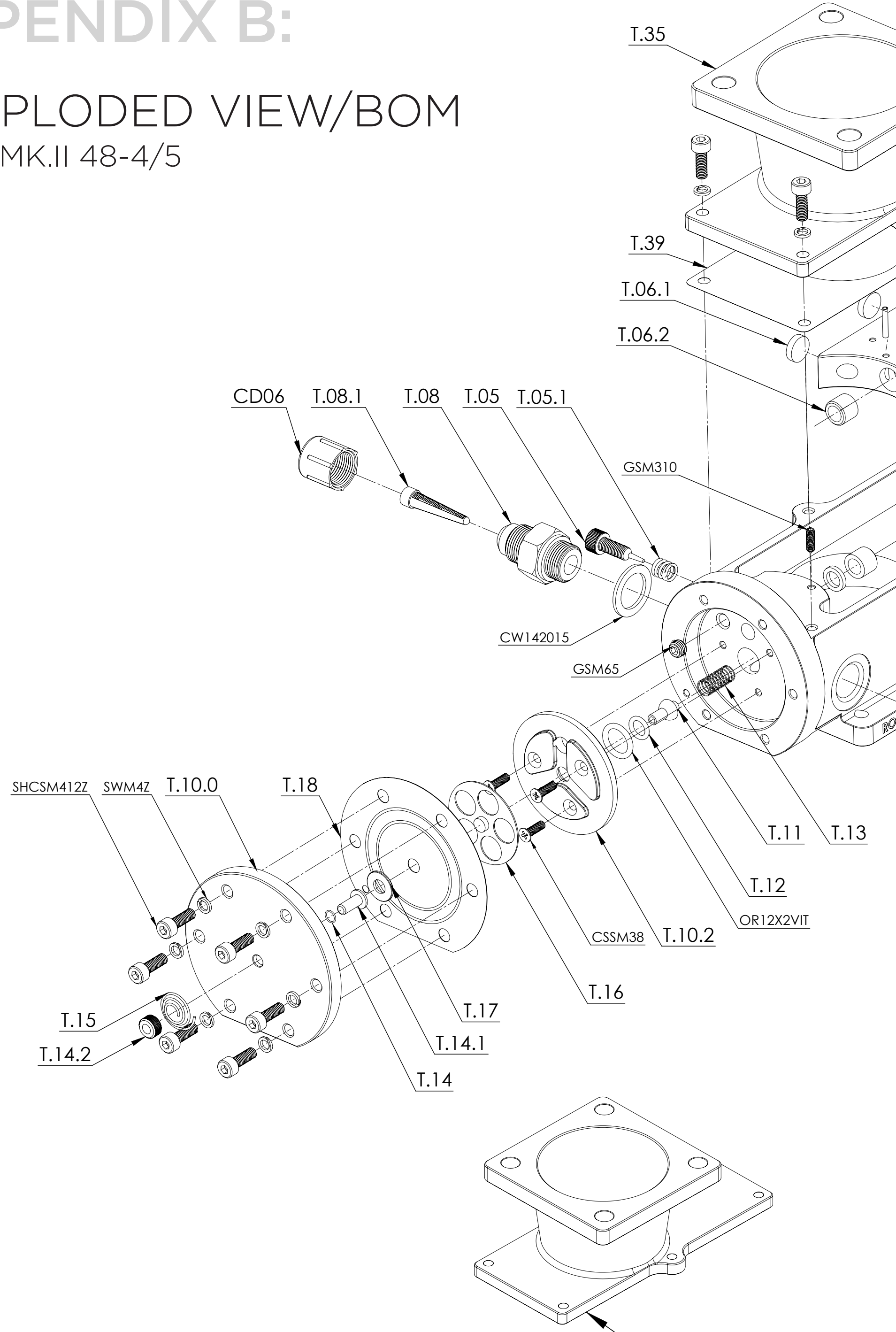
FASTENERS		
PART No.	**DESCRIPTION**	**QTY.**
CSSM38	Counter Sunk Screw M3	3
CW142015	Copper Washer 14 x 20	2
FW51658Z	Flat Washer M8	1
GSM65	Grub Screw M6 x 5	1
GSM310	Grub Screw M3 x 10	1
LNM81	Hexagon Nut M8	1
NM6Z	Hex Jam Nut M6	1
OR12X2VIT	Retaining Disk O-Ring	1
RPM212	Roll Pin M2 x 12	5
RPM220	Roll Pin M2 x 20	5
SHCSM412Z	Socket Head Cap Screw	12
SHCSM416Z	Throttle Stop Screw	1
SWM4Z	Spring Washer	12
SWM8Z	Lock Washer	1

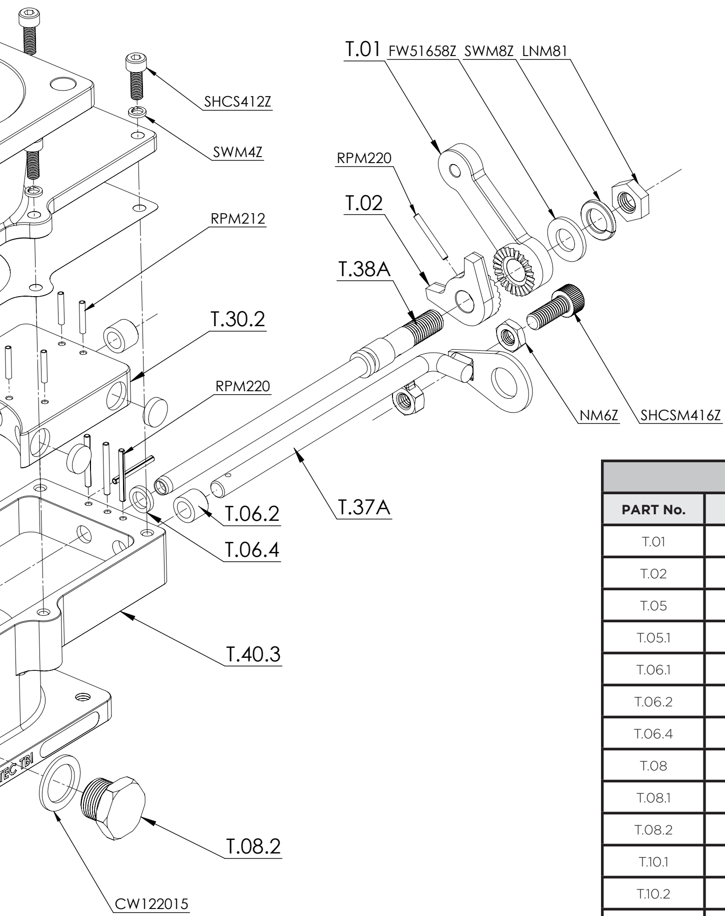
ROTEC TBI COMPONENTS		
PART No.	**DESCRIPTION**	**QTY.**
T.01	Mixture Arm Lever	1
T.02	Mixture Arm Boss	1
T.05	Idle Mixture Screw	1
T.05.1	Idle Screw Spring	1
T.06.1	Throttle Slide Pad	4
T.06.2	Rod Bush	4
T.06.4	Quad Ring	2
T.08	Fuel Fitting	1
T.08.1	'Last Chance' Fuel Filter	1
T.08.2	Fuel Plug	1
T.10.1	34-40 Regulator Cover	1
T.10.2	Regulator Valve Retainer	1
T.11	Regulator Flow Valve	1
T.12	1/4" O-Ring	1
T.13	Flow Valve Spring	1
T.14	Primer Button O-Ring	1
T.14.1	Regulator Override Shaft	1
T.14.2	Override Primer Button	1
T.15	Regulator Override Spring	1
T.16	Diaphragm Retaining Disk	1
T.17	Diaphragm Rivet Washer	1
T.18	Regulator Diaphragm	1
T.27	40-S Throttle Mount	1
T.30.1	34-40 Throttle Slide	1
T.31A	34-40 Throttle Control Rod Assembled	1
T.32A	34-40 Spray Bar Weldment	1
T.33	34-40 Teflon Gasket	1
T.40.2	40 Housing	1
CD06	Cap Plug	1

APPENDIX B:

EXPLODED VIEW/BOM

TBI-MK.II 48-4/5



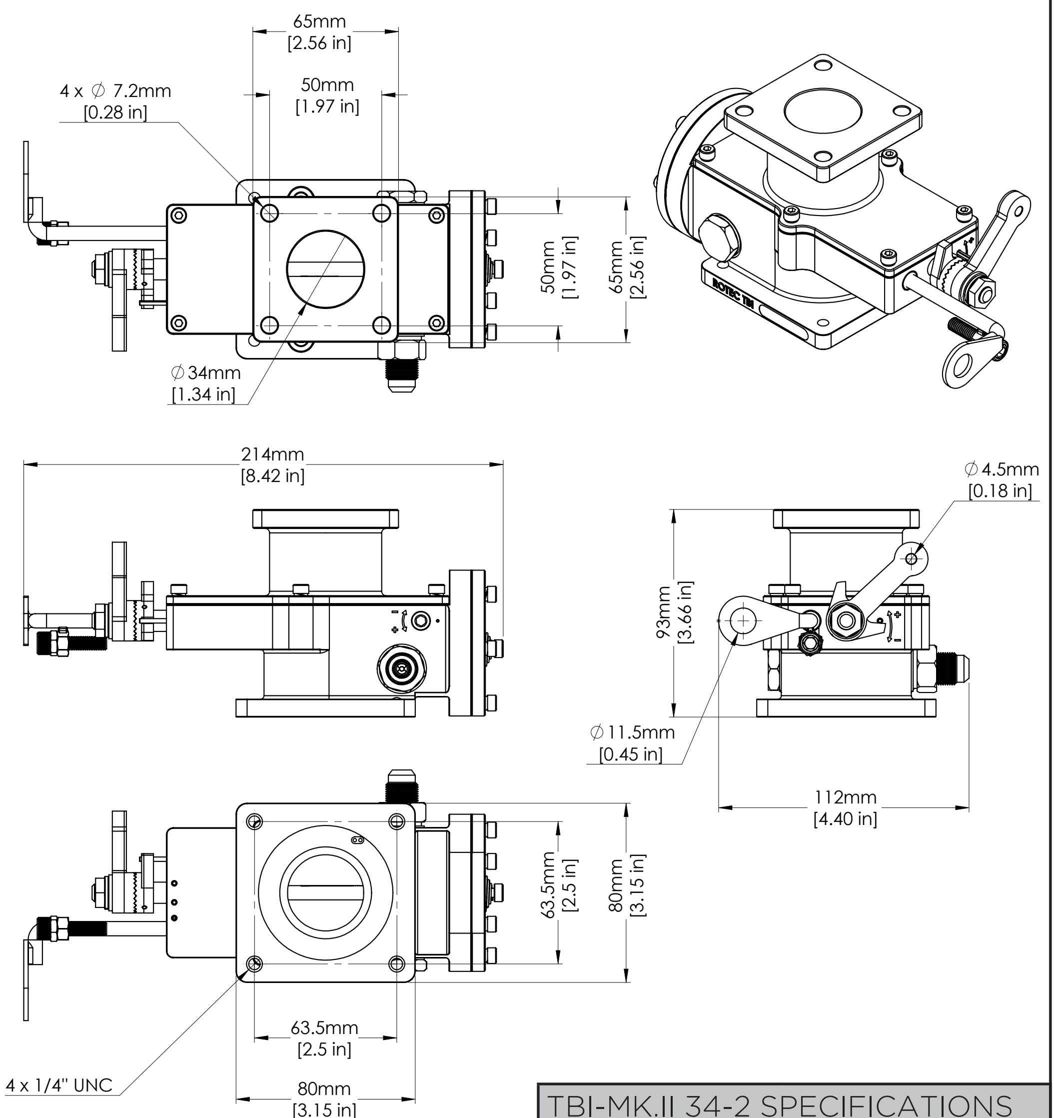


FASTENERS		
PART No.	**DESCRIPTION**	**QTY.**
CSSM38	Counter Sunk Screw M3	3
CW142015	Copper Washer 14 x 20	2
FW51658Z	Flat Washer M8	1
GSM65	Grub Screw M6 x 5	1
GSM310	Grub Screw M3 x 10	1
LNM81	Hexagon Nut M8	1
NM6Z	Hex Jam Nut M6	1
OR12X2VIT	Retaining Disk O-Ring	1
RPM212	Roll Pin M2 x 12	5
RPM220	Roll Pin M2 x 20	5
SHCSM412Z	Socket Head Cap Screw	12
SHCSM416Z	Throttle Stop Screw	1
SWM4Z	Spring Washer	12
SWM8Z	Lock Washer	1

ROTEC TBI COMPONENTS		
PART No.	**DESCRIPTION**	**QTY.**
T.01	Mixture Arm Lever	1
T.02	Mixture Arm Base	1
T.05	Idle Mixture Screw	1
T.05.1	Idle Screw Spring	1
T.06.1	Throttle Slide Pad	4
T.06.2	Rod Bush	4
T.06.4	Quad Ring	2
T.08	Fuel Fitting	1
T.08.1	'Last Chance' Fuel Filter	1
T.08.2	Fuel Plug	1
T.10.1	34-40 Regulator Cover	1
T.10.2	Regulator Valve Retainer	1
T.11	Regulator Flow Valve	1
T.12	1/4" O-Ring	1
T.13	Flow Valve Spring	1
T.14	Primer Button O-Ring	1
T.14.1	Regulator Override Shaft	1
T.14.2	Override Primer Button	1
T.15	Regulator Override Spring	1
T.16	Diaphragm Retaining Disk	1
T.17	Diaphragm Rivet Washer	1
T.18	Regulator Diaphragm	1
T.22	30-S Throttle Mount	1
T.30.1	34-40 Throttle Slide	1
T.31A	34-40 Throttle Control Rod Assembled	1
T.32A	34-40 Spray Bar Weldment	1
T.33	34-40 Teflon Gasket	1
T.40.1	34 Housing	1
CD06	Cap Plug	1

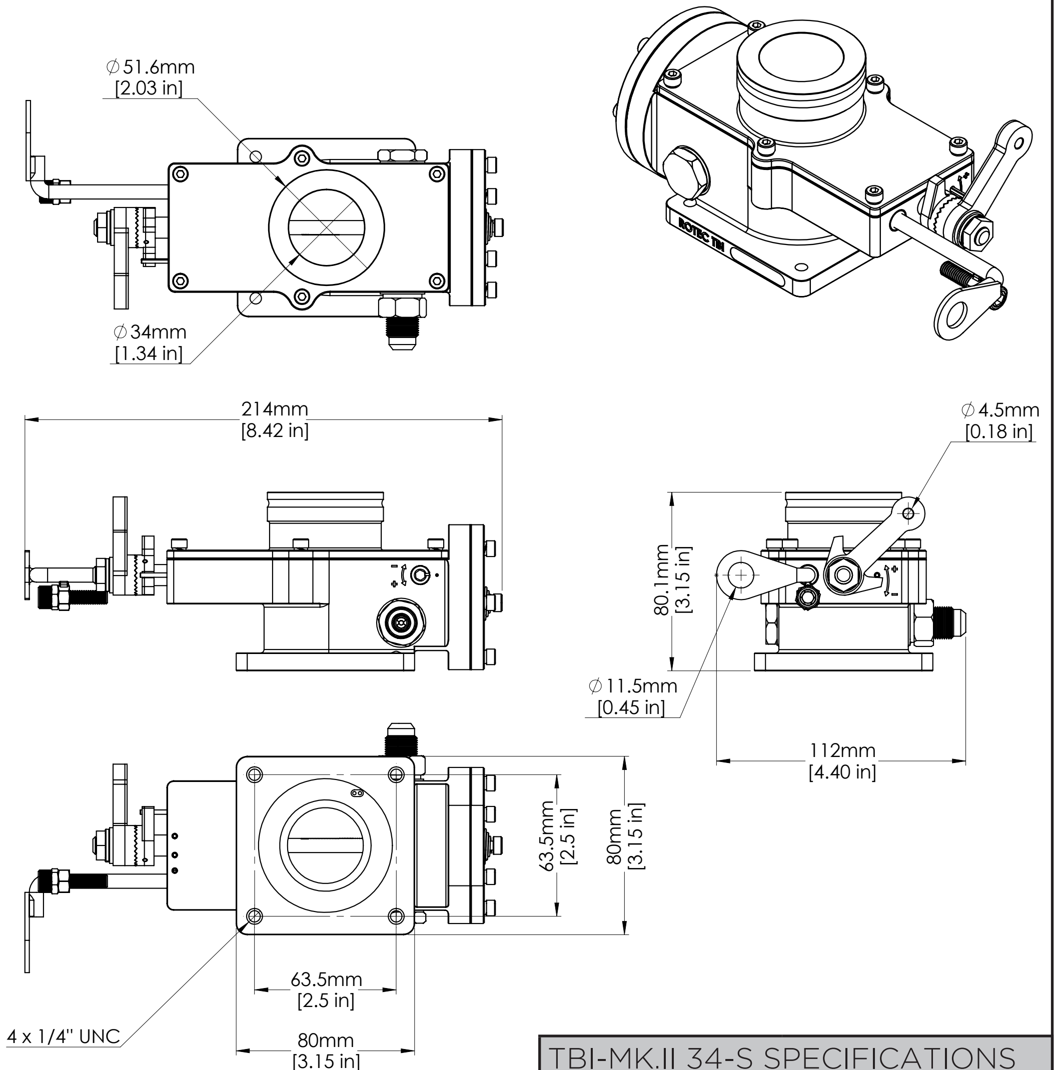
APPENDIX B:

KEY DIMENSIONS



DRAWING NOT TO SCALE

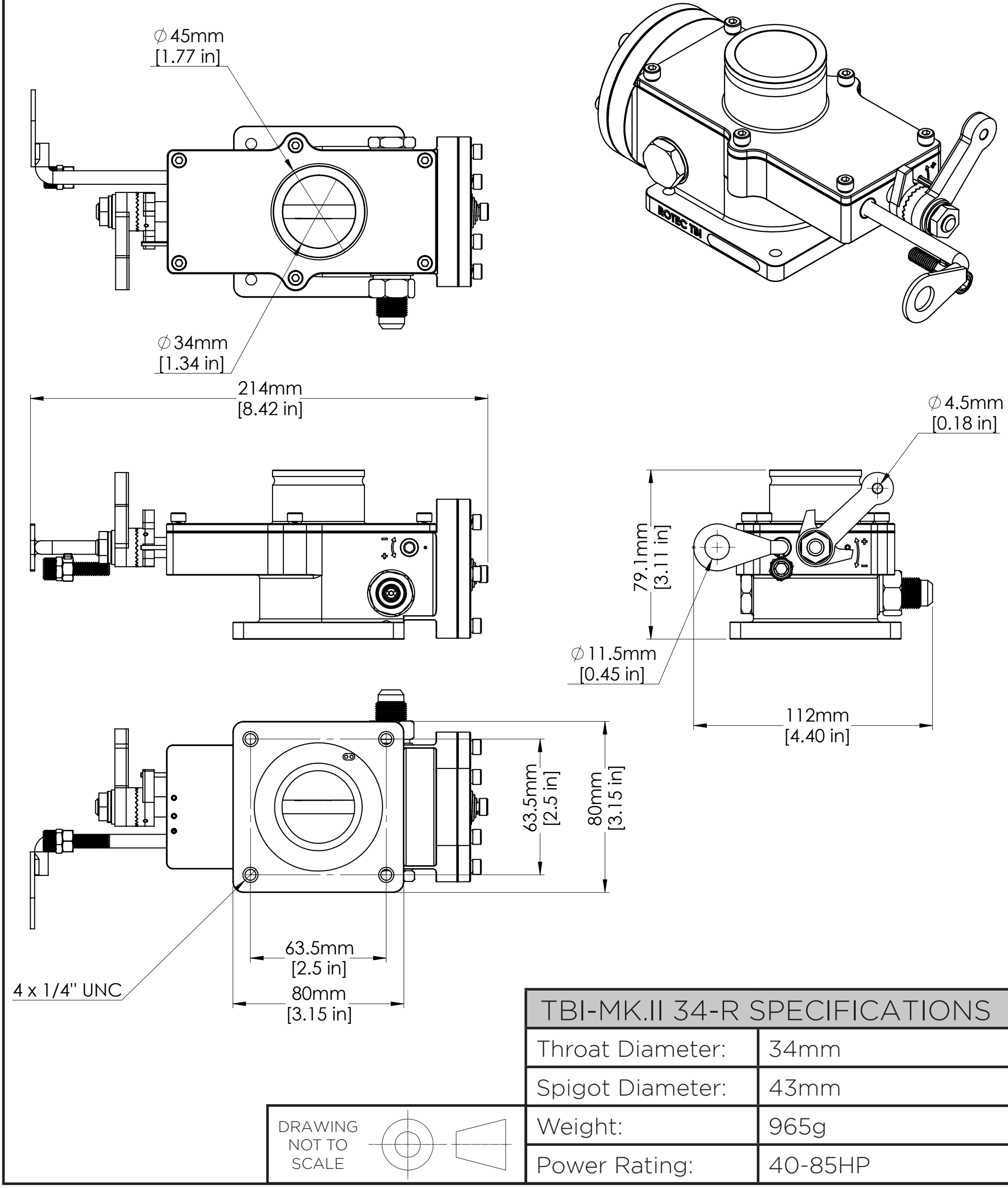
TBI-MK.II 34-2 SPECIFICATIONS	
Throat Diameter:	34mm
Flange:	Aviation Flange #3
Weight:	1074g
Power Rating:	40-85HP



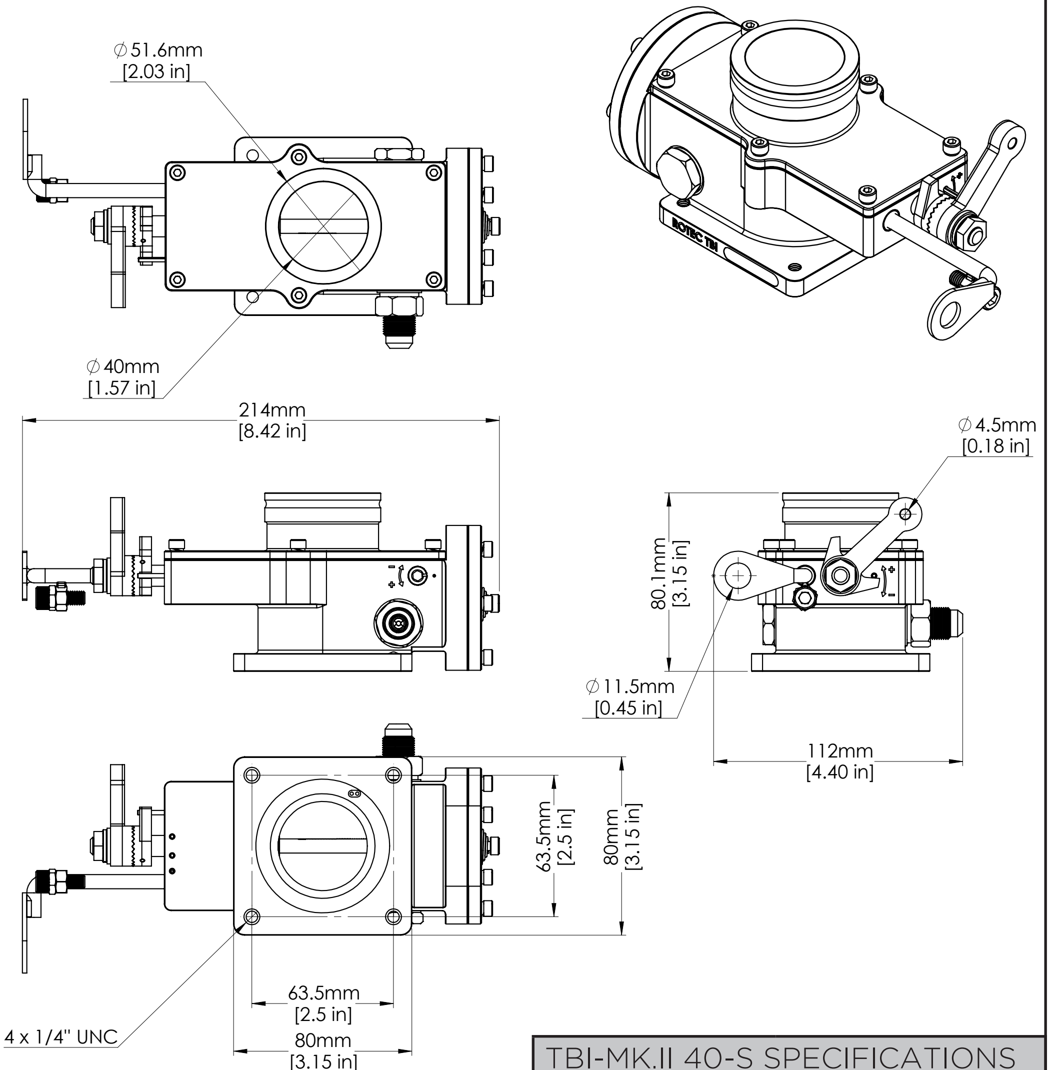
TBI-MK.II 34-S SPECIFICATIONS	
Throat Diameter:	34mm
Spigot Diameter:	50mm
Weight:	1003g
Power Rating:	40-85HP

DRAWING NOT TO SCALE

APPENDIX B:



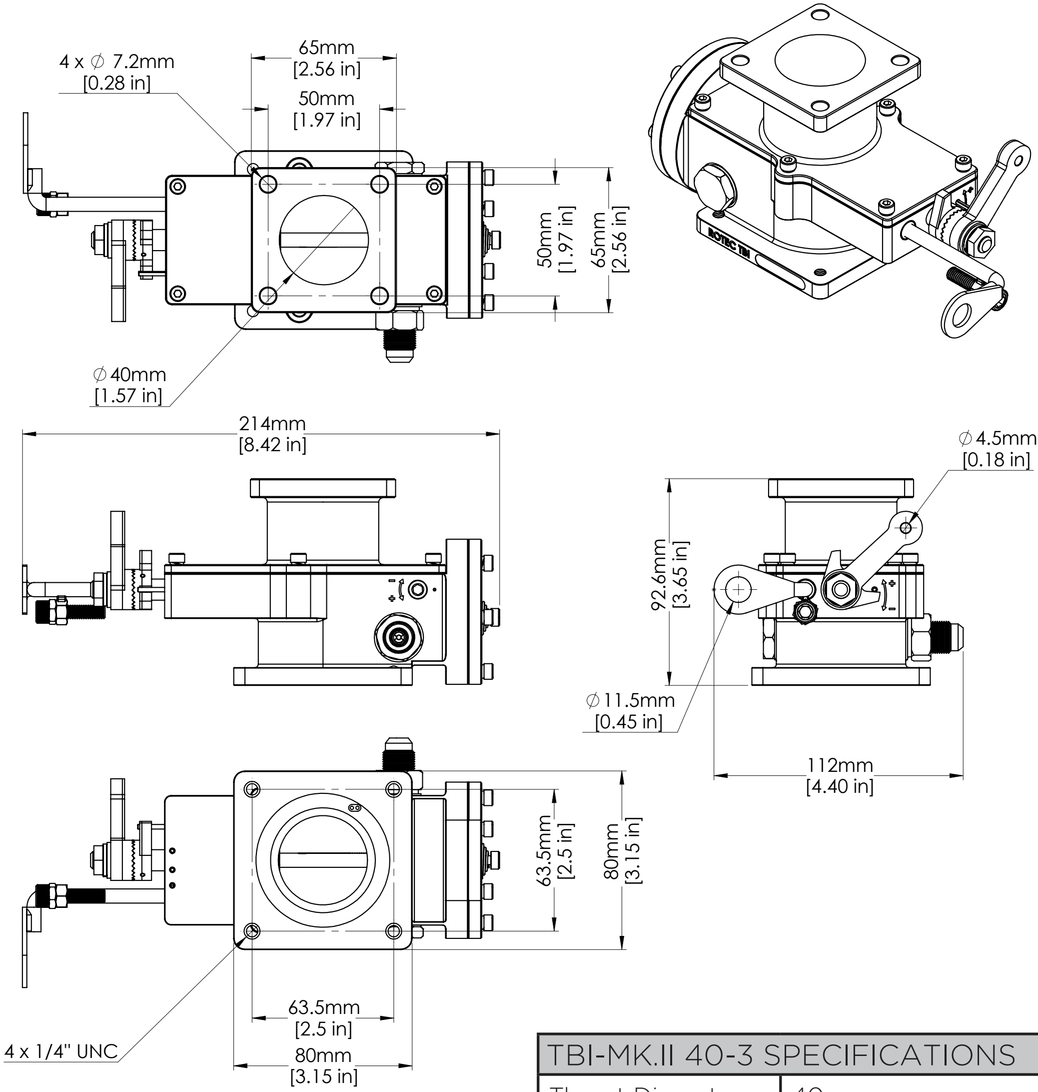
TBI-MK.II 34-R SPECIFICATIONS	
Throat Diameter:	34mm
Spigot Diameter:	43mm
Weight:	965g
Power Rating:	40-85HP



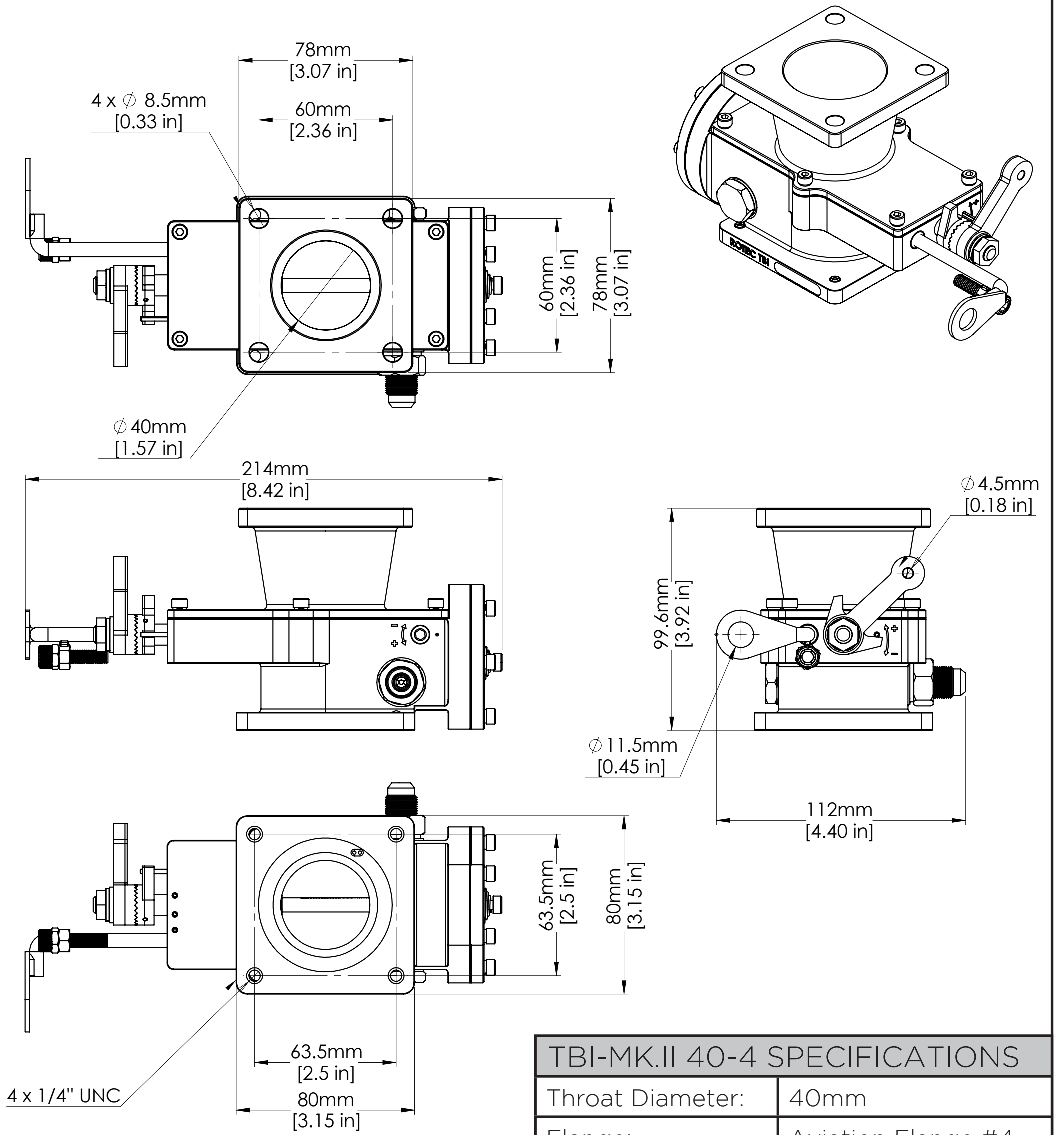
TBI-MK.II 40-S SPECIFICATIONS	
Throat Diameter:	40mm
Spigot Diameter:	50mm
Weight:	938g
Power Rating:	90-160HP

DRAWING
NOT TO
SCALE

APPENDIX B:



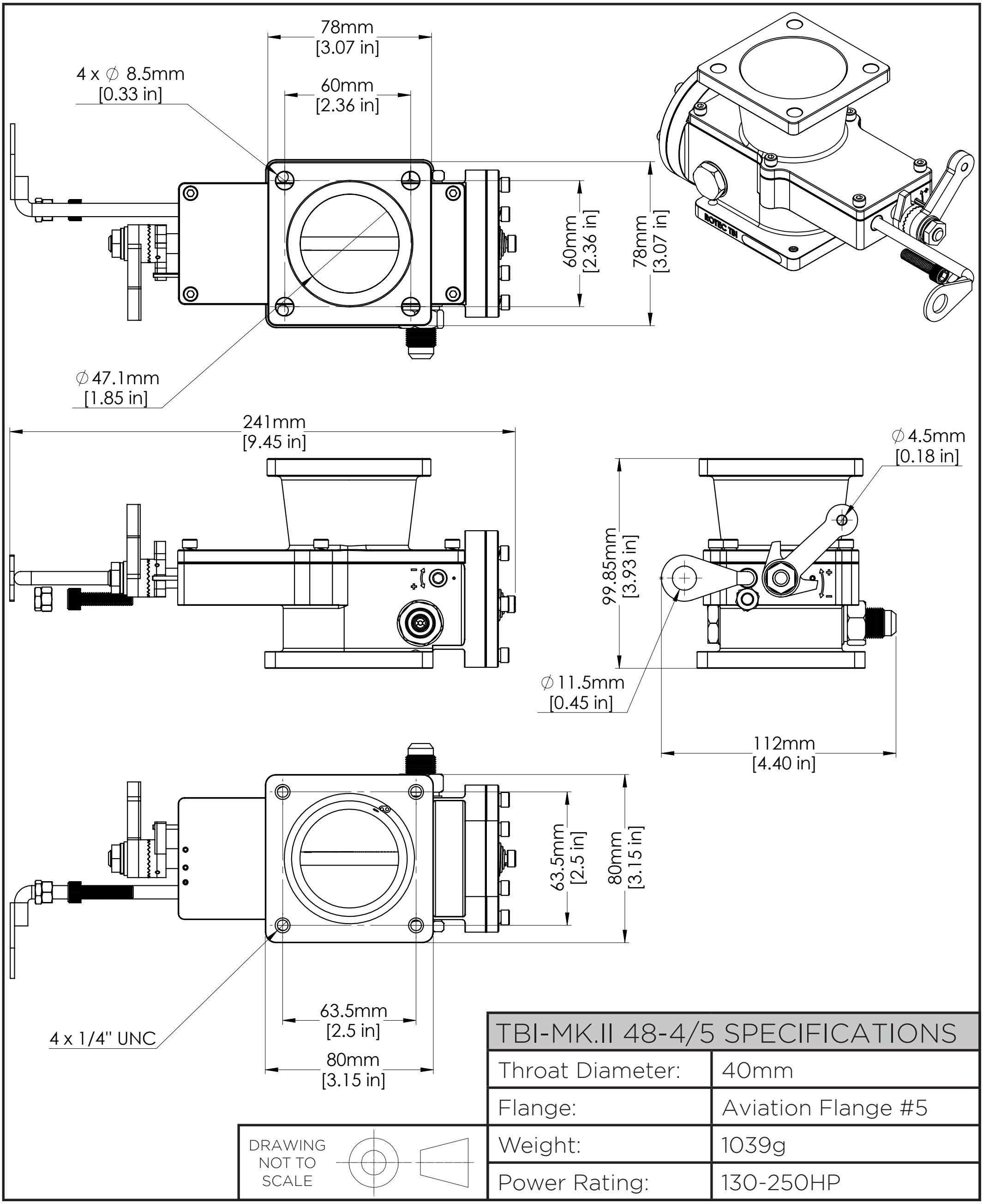
TBI-MK.II 40-3 SPECIFICATIONS	
Throat Diameter:	40mm
Flange:	Aviation Flange #3
Weight:	1003g
Power Rating:	90-160HP



DRAWING NOT TO SCALE

TBI-MK.II 40-4 SPECIFICATIONS	
Throat Diameter:	40mm
Flange:	Aviation Flange #4
Weight:	1085g
Power Rating:	90-160HP

APPENDIX B:



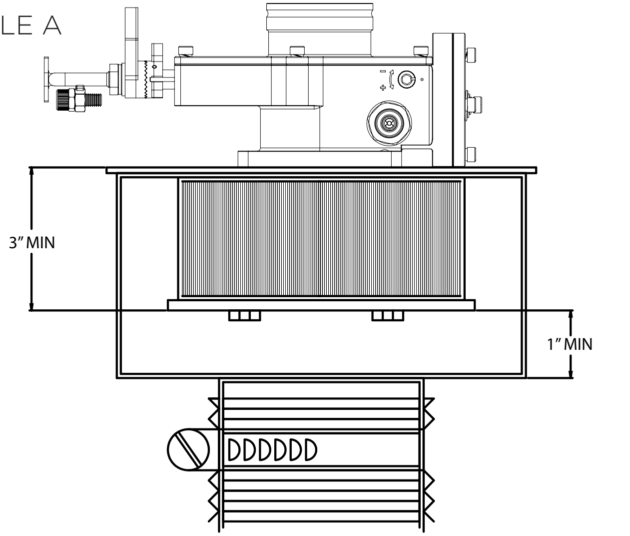
TBI-MK.II 48-4/5 SPECIFICATIONS	
Throat Diameter:	40mm
Flange:	Aviation Flange #5
Weight:	1039g
Power Rating:	130-250HP

APPENDIX C:

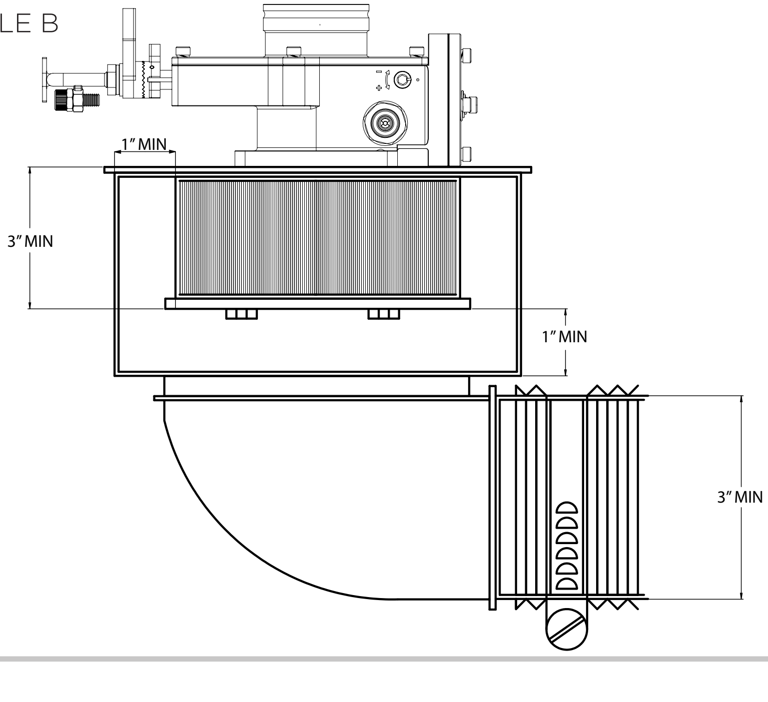
EXAMPLE INLETS

GOOD INLET EXAMPLES

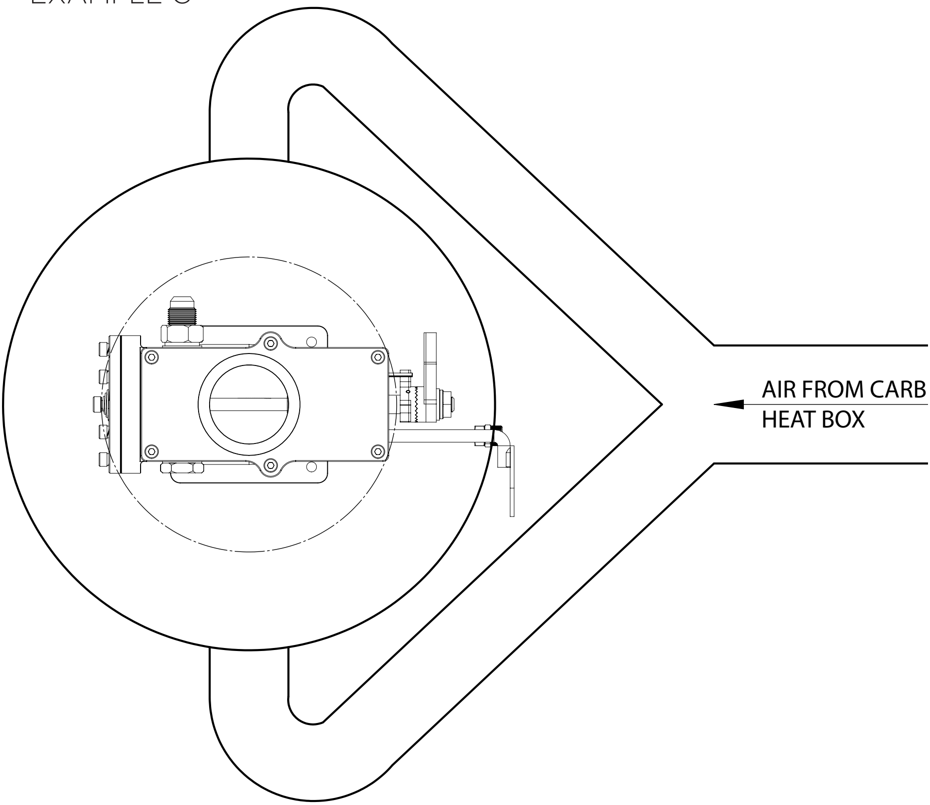
EXAMPLE A

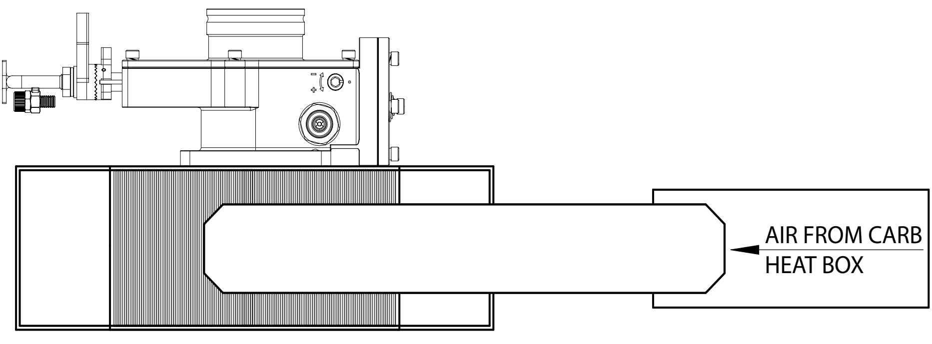


EXAMPLE B



EXAMPLE C



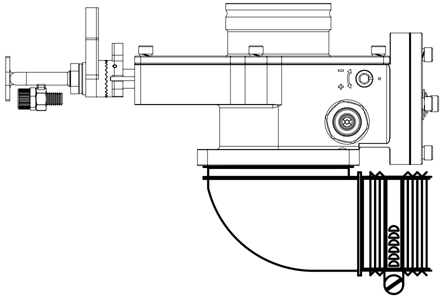


APPENDIX C:

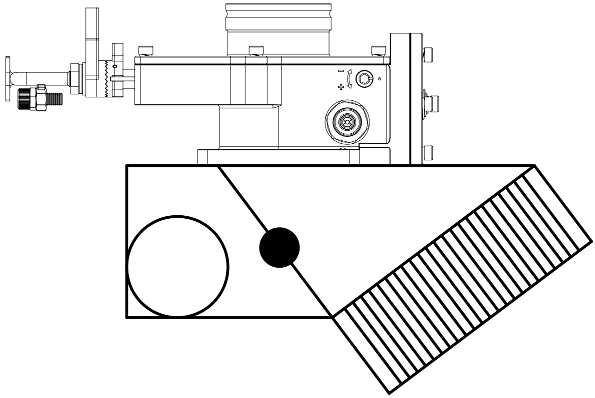
EXAMPLE INLETS

BAD INLET EXAMPLES

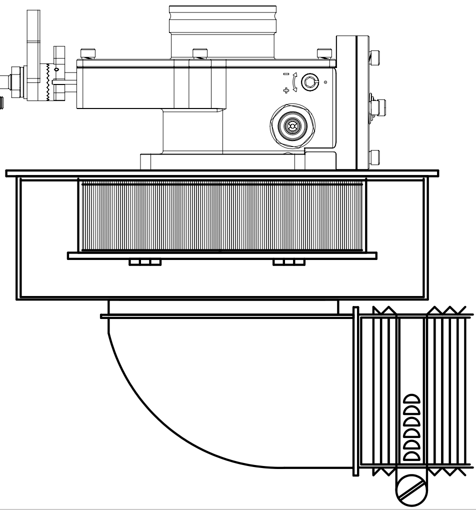
EXAMPLE A



EXAMPLE B

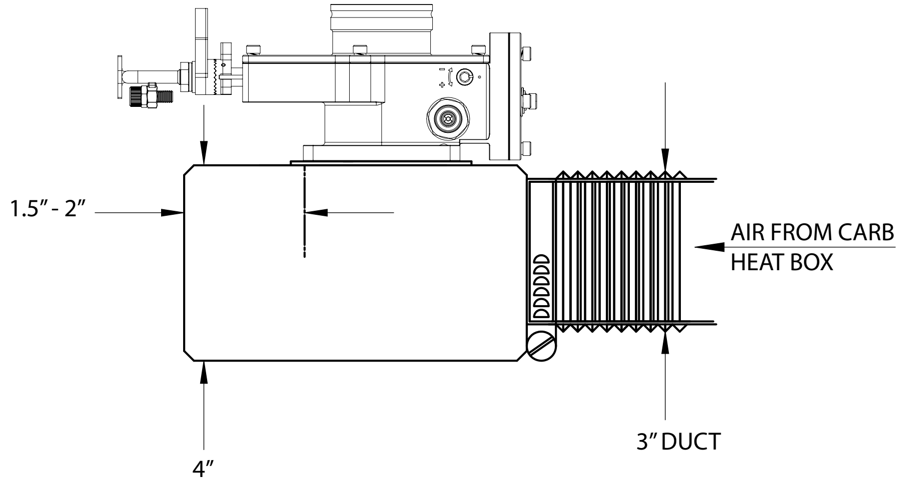


EXAMPLE C



LARGE VOLUME PLENUM CHAMBER

RECOMMENDED MINIMUM DIMENSIONS



APPENDIX D:

FAQ

FREQUENTLY ASKED QUESTIONS

SYMPTOM	POSSIBLE CAUSES
Dying at idle with engine cold.	Not unusual - idle setting must be adjusted when engine is warm. Without engine heat to evaporate idle fuel, the throttle must be opened slightly until the oil warms up.
Dying at idle when engine is warm on a warm or hot day but idle behavior stable on cool days or when engine is cold.	Vapour formation caused by fuel lines absorbing engine heat when fuel rate is very low. This problem is common with fuel injection systems and may be prevented by: 1.Careful insulation of all fuel system components 2.Blast cooling pumps, gascolator, filter, and flow transmitter. 3.Install vapour return line to tank per EFS instructions. Leak in fuel system on suction side of fuel pump allowing air to be drawn into fuel systems.
Idle setting seems to change.	Throttle slipping or unsupported. Ice: apply carb heat. Induction air leak between TBI and cylinders. Leaking throttle slide seal.
Excessively rich at idle conditions of visible moisture or high humidity.	ICE - apply induction heat.
Acceleration unsatisfactory	Idle mixture too lean. Induction air leak between TBI and cylinders. Mixture not in full rich position. Metering tube holes clogged.

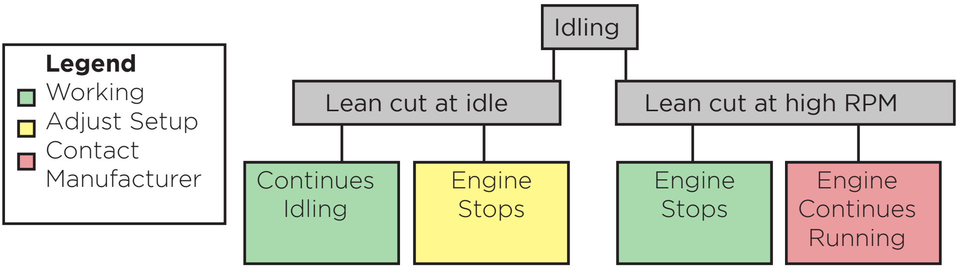
Excessive leanness at high power.	1.Full rich metering tube adjustment set too lean. 2.Inlet air turbulence caused by bad airbox configuration. Review section 2-9 of this manual. 3.Fuel system flow capacity limit (see section 2-2, item H). 4.Induction gasket or airbox flange blocking bellmouth reference probe. 5.Leak in fuel system on suction side of fuel pump such as leaking primer or pump lines which allows air to be drawn into fuel system. 6.Clogged fuel filter. 7.Clogged metering tube holes. 8.Vapor formation. 9.Defective fuel pump.
Leaking fuel after engine shutdown: 1.Less than 1 tablespoon 2.More than 1 tablespoon (leak continues)	1.Normal. 2.This sometimes occurs on new TBI units but should disappear after fuel inlet control valves have seated (usually within the first 10 hours of operation).
Engine roughness at wide open throttle.	Same cause as excessive leanness at high power.
Engine dies when throttle is slowly opened from idle.	Induction air leak between TBI and cylinders.
Engine roughness at wide open throttle (WOT) that tends to smooth out when mixture is leaned.	Inlet turbulence (see section 2-9) or rich stop set too rich.
Rich idle that persists after idle mixture screw is fully seated.	Indicates worn slide seals caused by ingestion of unfiltered air. Return TBI to Rotec Fluid Systems, Inc. for repair.

APPENDIX D:

TROUBLE SHOOTING GUIDE

TBI SCENARIO CHARACTERISTICS

A fully working TBI installation will have all of the following working characteristics marked in green. If your installation features any yellow characteristics follow the guide to adjust your setup and establish this problem has been corrected. If the problem persists, contact Rotec. If your installation features a red characteristic, contact Rotec as there is likely a defect.



LEAN CUT AT IDLE

When TBI spray bar faces incoming air stream.

CONTINUES IDLING

As fuel is no longer supplied by the spray bar, idle jet supplies sufficient fuel to maintain engine idle.

ENGINE STOPS

Idle yet is not supplying sufficient fuel at idle. Using the idle mixture screw on the side of the TBI adjust the mixture and try again. To richen the idle mixture, wind out the idle screw about 1/4 turn at a time. Out for rich, in for lean. The screw will need a 3/4 - 1 turn and no more than 1.5 turns from closed. Warning: Be careful not to over tighten the needle into taper or it can damage the idle jet. A combination of both the idle mixture screw and the throttle stop will result in best idle performance.

LEAN CUT AT HIGH RPM

When TBI spray bar faces incoming air stream.

ENGINE STOPS

As fuel is no longer supplied by the spray bar, engine stops. Idle jet is not able to supply required fuel to keep engine running.

ENGINE CONTINUES RUNNING

There is likely a leaking seal allowing the engine to continue running despite the TBI spray bar no longer supplying fuel.

For more commonly asked questions, please see our website at:

http://www.rotecaerosport.com/products/tbi

or contact us at: Technical@RotecAerosport.com