PROCEDURES FOR USE OF E5 UNLEADED MOGAS TO EN228

For many years now, suitable LAA aircraft have been able to be operated with unleaded Mogas fuel to EN228 standard, using procedures put into place by LAA Engineering that were based on a permission promulgated by the CAA initially as an Airworthiness Notice, and latterly as a 'General Concession' in CAP 747. Switching to Mogas provides a worthwhile cost saving and convenience particularly for owners based at farm strips and small airfields without on-site fuelling facilities. Furthermore, many engines (particularly Rotax engines) fitted to LAA aircraft don't cope very well with the high TET lead content in 100LL Avgas and using 100LL reduces some of these engines' TBO. For these owners, either lead-free UL-91 Avgas or unleaded Mogas are technically better alternatives.

All was sweetness and light until, starting around 2010, fuel companies started to introduce ethanol into Mogas, due to increasing political pressures to preserve fossil fuels. Under a quota arrangement mandated by EU directive, fuel companies throughout Europe are nowadays required by law to blend bio-fuel into their fuels, the most likely choice being ethanol, normally not exceeding 5% by volume under current legislation.

Until late 2014, Cap 747, Section 2, Part 4, General Concession 5 forbade the use of unleaded Mogas fuel containing alcohol in SEP aeroplanes (but not in microlights, interestingly), because of concerns that alcohol in fuel might damage the rubber and plastic components in the fuel system, and also cause problems through its propensity to absorb water which can suddenly come out of solution later, potentially flooding the water trap and fuel sump and stopping the engine in flight. In more concentrated solution, ethanol can also cause problems with corrosion of metallic components in fuel systems.

LAA members have responded by searching out those increasingly few suppliers still providing ethanol-free fuel, using a tester to check a sample of each draw-down. But over the last few years it has been increasingly difficult to find ethanol-free Mogas and increasingly members have grudgingly turned to the technically superior, but more expensive UL-91 fuel or to expensive leaded 100LL, with all the associated problems.

Under pressure to review their prohibition on alcohol in unleaded Mogas, in late 2014 the CAA responded by withdrawing General Concession 5 and the associated Safety Sense leaflet 4b instead transferring responsibility for choice of fuel and the provision of appropriate guidance to the aircraft's type design organisation – ie for aircraft operating on an LAA Permit to Fly, to the LAA.

Anticipating the problem, the LAA Engineering Department (headed up by former Engineering Director Barry Plumb) has carried out a great deal of investigation into this matter and concluded that with suitable checks and balances in place, up to 5% ethanol in Mogas need not prevent its use in suitable LAA aircraft/engine combinations. A further source of encouragement has been the fact that as the supply of ethanol-free unleaded Mogas has dwindled in recent years, experience with Mogas containing up to 5% ethanol in UK microlights and EASA LSA aircraft with Rotax and similar engines has not revealed significant new issues with the fuel. Where problems have occurred, it has been with chemical compatibility with composite fuel tanks, some of which have had serious leaks due to the cocktail of ethanol and petroleum dissolving the epoxy or polyester resin used in their lay-up.

In some cases, in particular the wing skins of 'wet wing' Jabiru aircraft, problems have appeared to have occurred with chemical attack of composite components by break-down products in fuel vapour from stale Mogas fuel which has been left in the tank for several months.

Problems have persisted with premature chemical degradation of various types of hoses and other rubber components used in microlight fuel systems but these perennial problems have not necessarily been attributable to alcohol in the fuel.

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On the other hand it should be noted that while there have been few problems with chemical compatibility with non-metallic hoses, seals, tank sealants etc in microlight and LSA aircraft, these aircraft are generally of recent manufacture and consequently use components designed in the era when the introduction of fuels containing alcohol was anticipated or already in use (ie for the automotive industry) and materials formulated accordingly. The same results may not be achieved with vintage aircraft which were designed to use aircraft fuels or traditional fossil-based motor fuels. For example we've heard of problems with the varnish used to seal the cork floats from the float chambers of Gipsy Major carburettors becoming gummy and breaking down, potentially leading to engine problems – and from what we hear, the supplies of spare Gipsy carburettor floats are extremely limited, with no alternatives presently being manufactured.

Taking everything into account, LAA Engineering have now changed the LAA Mogas procedures to allow up to 5% ethanol content in the fuel, (known as E5 to distinguish it from higher ethanol concentration E10 and E85 fuels) subject to the aircraft's fuel system components being checked and found chemically compatible and the engine manufacturer having approved this level of ethanol content. For engines where the manufacturer does not approve 5% ethanol being used, through the LAA mod scheme some LAA members are cautiously exploring tests on suitably modified engines where we believe the modifications address the perceived issues.

Eligibility

The use of E5 Unleaded Mogas to EN228 is accepted on any LAA aircraft subject to the following:

1. The engine manufacturer having made it clear to LAA Engineering that the engine type (or this example, where not all of type are the same) is in their view compatible with this fuel. Engine types currently satisfying this requirement are:

   Rotax 914 variants — see Rotax SI-914-019 R4
   Rotax 912 variants (including 912-UL, -ULS, iS) — see Rotax SI-912-016 R4
   Rotax two stroke aircraft engines — see Rotax SI-2ST-008
   Jabiru 2200A and 3300A (only eligible for examples with suitable compression ratio and combustion chamber shape, as defined in Jabiru JSL7 at issue -7 or subsequent – see also note below re wet wing Jabiru types)
   VW conversions (subject to compression ratio not exceeding 8.0:1 and hardened valve seats being fitted – but see also section on VW engines below).

   We anticipate this list of engines being expanded rapidly as further engines are investigated, see latest issue of this Technical Leaflet TL 2.26 on the LAA website for latest information.

2. The airframe fuel system has been determined by the owner, verified by the inspector, as being chemically compatible with this fuel. The checks made should include a physical check of the aircraft and a review of the airframe manufacturer's recommendations plus any associated service bulletins etc.

   Known problems exist with fuel tank chemical compatibility with ethanol in the following aircraft types:

   - Certain Jabiru aircraft per Jabiru service letter JSL7-7. See below.
   - Certain CFM Shadow variants per LAA AIL MOD/206/007

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- Certain MCR-01 variants

Consequent to the advice in Jabiru Service Letter JSL7-7, and as a result of problems with softening and rippling of the wing skins on UK based examples of ‘wet wing’ Jabiru aircraft, LAA has withdrawn the former approval to use Mogas of any sort in Jabiru J400 and J430 aircraft, as promulgated by LAA Airworthiness Information Leaflets MOD/325/004 issue 1 and MOD/336/002 issue 1. LAA considers that the Jabiru UL-D is also no longer approved to use Mogas on the basis of the content of JSL7-7.

Placards

A placard must be fitted on the instrument panel, or other location in clear view of the pilot in flight, stating:

USE OF E5 UNLEADED MOGAS

-only legal in aircraft specifically approved for the purpose
-fuel to be fresh, clean, water free and not exceed 5% alcohol content
-verify take-off power prior to committing to take-off
-tank fuel temperature not above 20° C
-fly below 6000 ft
WARNING - CARB ICING, WATER CONTAMINATION
AND VAPOUR-LOCK MORE LIKELY

A placard must be fitted alongside each fuel filler stating as follows:

E5 UNLEADED MOGAS
BS EN 228, 95 RON (MIN)

Placards as above are available from LAA Engineering, free of charge to LAA members.

Procedure for clearing eligible aircraft to use E5 Mogas

1. Download a copy of the latest issue of TL 2.26 from the LAA website
2. Download a copy of the applicable inspection checklist from the LAA website
3. Check that the aircraft’s engine complies with any stipulations stated on the checklist, and have this verified by your LAA inspector, signing up the checklist accordingly.
4. Check that the airframe fuel system is chemically compatible with unleaded Mogas containing up to 5% ethanol and record this on the checklist, verified by your LAA inspector. The checks made should include a physical check of the aircraft components (doing submersion tests where uncertain) and a review of the airframe manufacturer’s recommendations plus any associated service bulletins and individual aircraft fuel system modifications.
5. Fit the E5 unleaded Mogas placards to fillers and cockpit, as above
6. Staple the checklist into the aircraft’s logbook
7. Have your LAA inspector sign up appropriate airframe and engine logbook entries stating that the engine has been checked on accordance with LAA TL2.26 issue x and may be used with E5 unleaded Mogas in accordance with the operating procedures and special operating limitations described therein.
8. The aircraft may then be operated on E5 unleaded Mogas in accordance with the operating procedures and special operating limitations detailed in this TL 2.26

PROCEDURES FOR USE OF E5 UNLEADED MOGAS TO EN228

Obtaining and Storing Mogas

It is essential that the type of unleaded or super unleaded fuel used is to BS EN 228 of 95 RON minimum. Check the markings at the fuel pump.

The alcohol content must not exceed 5% by volume. The most readily available test method for detecting alcohol in petrol is the so-called ‘water extraction’ method which can be used to check for alcohol levels exceeding 5%. Alternatively a test kit has been developed that enables the detection of alcohol down to around 1%. Alcohol detection test kits are available from Airworld UK Ltd.

It is always preferable to buy Mogas for aircraft use from a supply at a garage with a reasonably high turnover and from a reputable supplier. We have come across problems in the past with cut-price supermarket fuel of poor quality.

Always store fuel in suitable clean containers. Fuel containers may be either metal, of up to 23 litres capacity and fitted with a secure leak-proof cap (Jerry can) labelled ‘Petroleum Spirit, highly inflammable’ or if plastic, it must be made for the purpose (complex regulations refer) and of no more than 5 litres capacity.

We are advised that the Road Traffic regulations normally applicable to carriage of petrol by road do not apply if the fuel is being carried for recreational purposes. No more than four containers, which must be made specifically for the carriage of petrol and have a maximum capacity of 20 litres each, may be carried.

If fuel is kept only for leisure purposes, we understand that up to 270 litres may be stored in one premises before having to apply to the County Council Petroleum Officer for a license. Nevertheless if more than 15 litres is stored then there is a legal obligation to inform the Petroleum Officer who must inspect and approve the premises. He will require the fuel store to be adequate for the job and to be equipped with a suitable nearby 6 Kg dry powder fire extinguisher. On the other hand, there is no requirement to contact the Petroleum Officer if the fuel is stored in the fuel tank of the aircraft itself. Nevertheless you should use common sense and also consider the implications regarding buildings insurance etc.

Apart from the obvious safety considerations, due to the short ‘shelf life’ of Mogas fuel compared to the more chemically stable Avgas, it’s best not to store large quantities. You are far better off purchasing small quantities of fuel as and when required, which will ensure that you always use fresh fuel blended appropriately for the time of year.

Ethanol Detection - Water Extraction Method

Alcohol can be detected in petrol using the Water Extraction Method, in which alcohol blended with petrol will react differently with water than unblended petrol. A petrol sample should be taken in a graduated glass vessel or laboratory test tube, after which water should be slowly added to the container to a level of approximately two inches. Once the petrol and water have settled and distinctly separated, the outside of the container should be marked at the phase separation point, for example using a wax crayon. Once the container is clearly marked, it should be stoppered and agitated for one minute, after which the contents should again be allowed to settle. An alcohol blended petrol will show a larger lower phase at this point, due to a phase separation of the ethanol and petrol and the ethanol then dissolving in the water. In effect, the lower phase is now water and ethanol with the upper phase of petrol. Once the ethanol and gasoline are separated, they cannot be re-blended via agitation; this phase separation is a one way process. If the sample is ethanol-free petrol, the water will settle at the previously marked level, with no apparent increase in the lower phase of the container. The reduction in volume of the liquid above the phase separation point after agitation indicates the volume of ethanol in the sample.

Records of Purchase

It is recommended that records are kept of all purchases of Mogas fuel so that if problems arise with any particular batch, it can be traced back to its point of purchase. Records should be kept until all of that batch has been consumed.

Quality Checks

Despite the lack of aviation-type quality control measures, over the last 30+ years that Mogas of various sorts has been identified as an aircraft fuel there have been few reports of problems due to contaminated fuel from garage forecourts. Even since the introduction of ethanol into fuel, we have not had reports from the flying fraternity of problems with water contamination, despite the greater propensity for water contamination of fuels containing ethanol. Nevertheless this is no excuse for lesser vigilance on the part of the pilot, and all Mogas fuel should be poured into the aircraft via a fine-mesh or chamois leather filter, and carefully sampled in the normal way. Watch out for flakes of paint in the fuel from the insides of metal 'Jerry cans'.

If the aircraft has been standing for 24 hours or longer, check that the fuel has not become contaminated with water before flight. It is generally preferable to keep tanks full whenever possible to minimise water condensation – the only exception being in hot weather when there may be a risk of the fuel becoming heat soaked and causing vapourisation problems – see below.

Only use fresh supplies of fuel and after a period of protracted storage, drain out any old fuel from the tank before filling up with fresh. Over a long period of time the fuel in the tank will evaporate away the more volatile 'fractions' through the tank vents, leaving a residue of low-volatility fuel which will cause poor starting, reduced performance and possibly engine damage through detonation or over-heating.

When in storage, Mogas fuel has a much greater tendency to form gum deposits than Avgas, so it has a much more limited 'shelf life' of just a few weeks. Avgas on the other hand can be kept in sealed drums for several years. Gum deposits can block carburettor jets and cause moving parts to 'stick'. Even if your engine appears to start and run well on last season's fuel, you should drain it off and replace with fresh.

Cases have been experienced where the vapour from stale Mogas appears to have caused softening and rippling in composite components, including in the wing skins of wet wing Jabiru aircraft. It has not been possible to establish with certainty whether this was a consequence of the fuel being stale, but it seems likely to be due to the break-down products generated by the fuel and its additives over a period of time.

Mogas fuel is also blended differently in the summer to that in the winter, to promote easy starting and driveability. Using summer fuel in winter may cause difficulty in starting, while using winter fuel in summer will increase the likelihood of vapour problems (see below)

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Filling up

When fuelling and de-fuelling, guard against 'flash fires' by electrically grounding the tank, funnel and can before transferring the fuel, and avoid a brimming funnel. If the stream of fuel from the 'source' encounters the fuel in the 'receiver' inside a closed container, the fuel/air mixture will almost certainly be too saturated to cause a fire should a spark occur. If, on the other hand, the fuel stream encounters a brimming funnel in free air then the petrol vapour in the vicinity may well be in the critical region where the tiniest spark will cause a flash fire.

Operating Limitations

Due to its greater tendency to vapour lock, unleaded Mogas fuel is restricted to operation with a fuel tank temperature not exceeding 20° C and an altitude not exceeding 6000 ft. These additional limitations must be displayed in the cockpit using a suitable placard (see above).

Special steps may be needed to prevent the fuel tank temperature exceeding 20° C, especially during summer. Avoid letting the aircraft heat soak in the sun for long periods before flight, especially if the part containing the tank is painted a dark colour. On a hot sunny day, avoid parking the fuelled-up aircraft on dark tarmac surfaces. Consider instead filling the tank with cold fuel shortly before take-off, or better still, leave in the cool of morning rather than after a prolonged soak in the midday sun.

Assuming that your aircraft is cleared for use with unleaded Mogas and with Avgas 100LL or UL91, there is no problem with mixing these fuels in your tank. Note however that even with just a small proportion of Mogas in the tank, the vapour pressure of the mixture will be almost as high as that of pure Mogas, so all running on a mixture containing Mogas must be carried out observing the operating limitations for unleaded Mogas alone.

What about Vapour Lock ?

Unleaded Mogas, like the obsolete four-star Mogas fuel, has a much higher vapour pressure than 100LL or UL91 Avgas. The initial boiling point of the fuel is only slightly above ambient temperature, so it takes only a slight raise in temperature or drop in pressure to make it start to vapourise. This unfortunate property of Mogas makes it much more likely to suffer vapour-lock or vapourisation problems than Avgas, especially in hot weather or at high altitude. Hence the limitations to 20° C and 6000 ft altitude which apply to Mogas use, and the requirement to check that full engine power is available before committing to a take-off. These special power checks should not be rushed, as they also serve to burn off the fuel which may have become pre-warmed in the fuel pump and gascolator while the engine has been idling, and drawing fresh, cool fuel through from the tank which will be less likely to cause vapour problems on take-off.

When the fuel turns to vapour in the fuel system, this can cause a number of different problems and it is important for Mogas users to understand the implications. If the vapour collects and forms a large bubble which becomes entrapped at a high point or constriction in the fuel pipe, this can form a 'vapour lock', effectively preventing the passage of fuel to the engine and causing a 'dead cut' similar to what would happen if you were to turn off the fuel cock. If this should occur, FLY THE AEROPLANE, lower the nose, trim for best glide speed and if sufficient height is available in which to experiment, turn on an auxiliary fuel pump if you are fortunate enough to have one, and select another fuel tank. If the auxiliary fuel pump is already on, you might try turning it off.

If on the other hand the fuel vapourises from some hot spot or low pressure area in the fuel system but does not become entrapped, a stream of vapour bubbles will enter the carburettor along with the fuel, causing raised EGTs, lean running and reduced power, which in the typical fixed pitch propeller installation is evidenced by a loss in indicated rpm and possibly puffs of white smoke in the exhaust. With Mogas, when carrying out the special power check prior to committing to take off you should be looking and listening not only for signs of uneven running but also an rpm which is less than normal on the tachometer, either during the run-up or during the initial stages of the take-off run. If either of these signs of vapourisation occur, you MUST abandon the take-off as the symptoms may well worsen as the engine heats up, and the power level may fall away to nothing during the climb-out.

If vapourisation is suspected in flight, FLY THE AEROPLANE, lower the nose to maintain airspeed, reduce the throttle setting so that the airflow into the engine is reduced to correspond with the enfeebled fuel flow, and richen the mixture control (if fitted) which should at least restore the fuel mixture strength, smooth running and possibly yield a few extra rpm. Since the symptoms may also resemble those associated with carburettor icing, carburettor heat may be required although this may have an adverse effect on fuel vapourisation problems and you will need to experiment to identify the cause of the problem before you can cure it.

Vapour problems are most likely to occur in aircraft fitted with engine-driven mechanical fuel pumps, and are rarely experienced with a purely gravity-fed system or those with an electric fuel pump situated at the tank outlet or, better still, submerged in fuel within the tank itself as in modern automotive practise. Unfortunately, in the typical aircraft system the fuel pump is located above the fuel tank, so the fuel pressure on the upstream side of the fuel pump is reduced below atmospheric by the action of the pump sucking up the fuel, making it very vulnerable to fuel vapour formation on the inlet side of the pump, with symptoms as described above.

If the engine is fitted with a mechanical pump, bolted to the engine crankcase, then heat conducted into the pump from the engine crankcase will raise the temperature of the pump body significantly and only the flow of cool fuel through the pump keeps the pump temperature moderate. When the engine is shut down after a flight, the cooling airflow through the engine compartment ceases along with the flow of cool fuel through a mechanical engine-driven pump. As a result the pump body temperature can rise alarmingly and particularly when using the more volatile Mogas, you may hear the fuel in the pump boiling. You may then notice the engine dripping fuel from the intake drain onto the ground, due to the vapour pressure of the boiling fuel pushing the contents of the carb float chamber past the float valve and into the venturi.

To cool the engine compartment after shut-down it may help to open cowling hatches and prop them open to promote convective airflow through the engine compartment. Remember to latch them down before flight though.

If the fuel should vapourise within the fuel pump due to elevated pump temperature, the fuel vapour generated inside the pump body cannot escape back into the fuel system upstream, because of the one-way valve on the intake side of the pump. So instead, the vapour expands past the outlet valve of the mechanical pump, in so doing pressurising the fuel in the fuel pipe and carburettor float chamber, causing a so-called ‘pneumatic lock’. The vapour pressure of the boiling fuel is enough to push the fuel past the carburettor float valve and the engine suffers a rich cut, with raised fuel pressure indications, rough running and characteristic sporadic black puffs of exhaust smoke. The most likely time this will occur is when the aircraft is flown, landed, parked for a short time and then a second take-off is made. If this should occur in flight, FLY THE AEROPLANE, lower the nose to maintain airspeed, reduce the throttle setting to that appropriate to level flight and attempt to restore smooth running by leaning the mixture.

If your aircraft has a mechanical pump with a back-up electric pump connected in parallel, then it is important not to switch the electric pump off too early after take-off, especially with Mogas, as there is a risk that the fuel in the mechanical pump may have been stagnant and vapourised away while running on the electric pump, in which case the engine will stop as soon as the electric pump is switched off. When you do switch off the electric pump, keep your finger on the switch for a few seconds and be ready to switch it back on should the engine start to misbehave. Check the fuel pressure gauge for flickering or a reduced reading.

Fuel suppliers provide higher volatility fuel in winter to help cold-starting. Be particularly wary of vapour problems in spring and autumn months when winter fuel is being supplied but ambient temperatures may be moderately high.

With a pump-fed engine, a vapour return line is often used to try to alleviate problems with vapour lock. This line allows a proportion of the fuel passing through the engine-driven pump to recirculate back to the fuel tank, its flow carefully restricted by a small in-line fixed orifice. This has two benefits – first it allows vapour that may have collected in the fuel line to be vented back to the tank, rather than collecting at and pressurizing the carburettor fuel inlet, and secondly by allowing an increased flow rate of fuel through the fuel pump (especially at low engine RPM, and hence minimal fuel demand by the engine) it helps cool the fuel pump by the passage through it of fresh cool fuel from the tank.

A simple piece of test equipment is available which allows the pilot to test the volatility of his fuel and likelihood of vapour problems during the pre-flight check. This is known as a Hodges volatility tester, and is available at a modest price from Petersen Aviation Inc. in the USA, tel. 001-308-832-2050.

Carburettor Icing

The greater volatility of Mogas compared to Avgas means that the carburettor throat temperatures are lowered more by the atomisation of Mogas at the jet than occurs with Avgas. Tests by the BGA showed that with the same ambient conditions, the carb throat temperatures of a Lycoming 0-360 were typically 7° C lower with winter grade Mogas than Avgas. The result is that when using Mogas, carburettor icing will commence under an even wider range of temperature and humidity conditions than with Avgas.

Take particular care to check the efficiency of any carburettor heating provisions and to watch out for signs of carburettor icing in flight. When using Mogas, use carb heat more frequently and for a longer period than normal especially on days when carburettor icing is likely. Carburettor ice remains a frequent cause of engine failures, which suggest that fitting a proprietary ice detector system to the carburettor may give a useful safety benefit.

Chemical Compatibility

During the daily check and other routine inspections, pay particular attention to non-metallic fuel pipes, fuel valves etc for signs of leaks due to chemical attack from the fuel. There is a possibility that moulded composite fuel tanks, fabricated honeycomb board fuel tanks, rubber pipes, seals, gaskets, O-rings, fuel tank sloshing sealants and even the varnish on cork fuel gauge floats may be affected by constituents within unleaded fuel. Standard MS29513 aviation O-rings swell significantly in size when in contact with unleaded Mogas, which may affect the operation of fuel valves, gascolators, fuel filler cap seals etc. All these points should be borne in mind during your pre-flight checks. You should also check filters frequently for signs of contamination either from the fuel or resulting from chemical attack on fuel system components or the fuel tank.

Cases have been experienced where the vapour from stale Mogas appears to have caused softening and rippling in composite components, including in the wing skins of wet wing Jabiru aircraft. It has not been possible to establish with certainty whether this was a consequence of the fuel being stale, but it seems likely to be due to the break-down products generated by the fuel and its additives over a period of time.

Water absorption

Water contamination problems can occur due to condensation inside tanks or directly by liquid water introduced inadvertently either at the source of supply, in storage, during filling or while in the aircraft tank. The normal advice is to keep fuel tanks full when the aircraft is not in use, to minimise condensation problems, but for aircraft with low utilisation this should be balanced against the other risks from using old fuel rather than fresh.

E5 Mogas has a greater tendency to become contaminated with water than 100LL fuel, because of the strong affinity of ethanol to absorb water (either from vapour from the air or in liquid form) under certain temperature and pressure conditions, and for the water to come out solution later and be trapped in the tank in liquid form, when the ambient conditions have changed (reduced temperature and pressure, for example as the aircraft climbs to altitude).

Condensation is a particular issue with aircraft fuel systems because they typically operate with vents open to atmosphere, unlike the closed systems fitted to modern cars where for environmental reasons this kind of arrangement is not allowed.

In practise, while water contamination of today’s unleaded petrol has been a big problem with outboard motors in small boats, in aircraft using mogas fuel there have been few reported problems, most having been traced to ill-fitting fuel cap seals allowing rainwater to leak into tanks while the aircraft was in flight or while parked outdoors.

In service difficulties

If fuel compatibility problems or other operational difficulties are experienced when operating in accordance with this TL 2.26, please advise the LAA Engineering Airworthiness Engineer at the earliest convenient opportunity.

While the advice here is based on the best information available at the time, ultimately Mogas supply is not as tightly controlled as Avgas and there is therefore more scope for problems of contamination or mis-identity. No guarantee can be given that fuel is of the type specified on the pump, and only by constant vigilance can safety standards be maintained. Remember that engine failure is always a possibility in single-engined aircraft. Consequently the pilot has a duty to operate it in such a way that engine failure would not case a hazard either to himself, his passengers or third parties on the ground. This advice is also only applicable to LAA aircraft and only those aircraft cleared by the LAA for use with E5 unleaded Mogas.

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Appendix 1 - Advice regarding specific engine types

Jabiru Engines

Jabiru advise that certain of their engines are designed to operate with E5 Mogas. - refer to Jabiru Service Letter JSL 007-7 (or later issues) for full details of applicability.

Jabiru warn that although their engines may be operated on 95 UL Mogas provided the compression ratio is not more than 8.3, and subject to the combustion chamber configuration, there is nevertheless an increased risk of detonation when unleaded fuel is used rather than 100LL Mogas. An installation which is marginal with regard to cylinder head cooling may suffer problems with detonation and engine damage when transferred to Mogas fuel. Be particularly wary of any signs of detonation, warped or leaking heads which may be a sign of detonation occurring which, if left unchecked, are likely to result in major engine damage and in-flight engine failure.

VW and VW based Engines

VW and VW based engines are suitable for 95 UL Mogas use, provided that the engine's compression ratio does not exceed 8.0:1 although there is the possibility that engines not fitted with hardened valve seats may suffer from rapid valve seat recession if deprived of the dry-lubricating effect of tetraethyl lead in leaded fuels. To guard against this possibility, if uncertain of their valve seats it is recommended that users of VW and VW based engines cleared for unleaded Mogas use should either use a fuel mixture with 10% 100LL in it or run a tankful of 100LL through the engine at least every 10 tankfuls to lubricate the valves and valve seats.

Checking the compressions by turning the propeller by hand should give an indication if valve seat recession has become excessive, but the valve clearances must be measured at least once ever 25 hours and adjusted if the clearance is found to be on or out of limit. Excessive exhaust valve clearance will introduce the possibility of valve burning which may lead to engine failure.

If you have the engine top overhauled or 'majored', it is recommended that you run the engine on 100LL Avgas for the first 10 hours of operation afterward to ensure adequate lead content during the break-in period.

Due to the likelihood of 100LL being withdrawn in the not too distant future for environmental reasons, it is recommended that when VW and VW based engines come to be overhauled, the cylinder assemblies are replaced with new assemblies known to be compatible with unleaded fuel, which will not require this occasional 'doping' with leaded fuel.

The chemical compatibility of VW and VW derived engines with Mogas containing up to 5% ethanol will be dependent on the individual type of carburettor and fuel pump fitted, which vary widely. Owners must determine for themselves whether these components are 5% ethanol compatible or not, for example by carrying out immersion tests or, for factory-produced engines, in consultation with the engine manufacturer.

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Continental and Lycoming Engines

Whilst many low-compression Continental and Lycoming engines have in the past been cleared to run with unleaded mogas in the UK, these engines are not approved by their manufacturers for use with mogas containing ethanol. As far as we are aware, at this time, chemical compatibility with mogas containing up to 5% ethanol has not been proven with carburettors, fuel injectors or fuel pumps fitted to Lycoming or Continental engines. LAA members are currently (July 2015) involved in testing engines fitted with different fuel pumps and carburettors with a view to finding a technical solution, but would also welcome any feedback from the field about real-world experiences using Mogas in unmodified engines of these types, where fuel containing ethanol may have been used inadvertently.

With these engines, many of which were originally produced many decades ago, there have been a variety of different valve seat and valve materials used over the years, and there is a slight possibility that some combinations in the field might suffer problems with valve seat recession if deprived of the dry-lubricating effect of tetraethyl lead in leaded fuels.

Due to the likelihood of 100LL being withdrawn in the not too distant future for environmental reasons, it is recommended that when Continental or Lycoming engines come to be overhauled, the cylinder assemblies are replaced with new assemblies known to be compatible with unleaded fuel.

Some Marvel-Schebler (latterly, Facet and now ‘Precision Airmotive’) carburettors may still be fitted with moulded cellular rubber floats, as introduced by FAA AD 66-05-04 (withdrawn in 1985). Some of these floats have given trouble due to soaking up fuel, loosing buoyancy and dropping in level, causing rich running problems, i.e. flooding carburettor, rough running at idle speed and inconsistent shutdown. Facet Service Bulletin A1-84 refers. Owners should be wary of this problem and if problems are experienced, consider fitting a replacement float (Precision Airmotive Service Information Letter SIL MS-4).

Some Bendix NAS-3 carburettors may still be fitted with obsolete synthetic rubber-tipped needle valves, which should have been replaced with a Delrin-tipped needle under Bendix Aircraft Carburettor Service Bulletin ACSB-84. Owners should be aware of this potential problem if they suspect that the neoprene-tipped valves are still fitted.