MAR 2022

UK Civil Aviation Authority

FUEL HANDLING AND STORAGE

SAFETY SENSE

SS28

YOUR SAFETY SENSE LEAFLET FOR:
FUEL HANDLING AND STORAGE

Ensuring fuel is appropriate with respect to grade, quantity and quality is essential for safe aircraft operations.

This leaflet is intended to give practical guidance on the dispensing, handling and storage of fuel for use in GA aircraft. While this guidance may be of use to professional fuel installation managers, the main audience is GA pilots who may dispense or store fuel themselves.

Some aspects of storage and fuelling installations are addressed, however the detail of specification and construction are beyond the scope of this publication.

FUEL HANDLING AND STORAGE

Responsibilities

All those involved in the dispensing, handling and storage of aviation fuel at aerodromes have responsibilities under Article 220 of the **Air Navigation Order (ANO) 2016** – 'Aviation Fuel at Aerodromes' to ensure that the storage of fuel is appropriate and will not render it unfit for use in aircraft.

These legal responsibilities apply equally to fuel being stored or dispensed at licensed or unlicensed aerodromes. The term 'aerodrome' includes any land or water set aside for the landing and departure of aircraft. This includes private airstrips, helicopter pads or any other site where aircraft operations take place. A pilot or other person who stores fuel, whether aviation gasoline (AVGAS), JET A-1 or motor gasoline (MOGAS), or even just fills an aircraft from a container, has the same legal and safety responsibilities as a professional fuel installation manager.

Hazards

There are three basic hazards associated with aviation fuel:

Fire and explosion

Incorrect type or quality

Environmental contamination

Everyone involved in fuel handling should be constantly aware of these hazards and make every effort to minimise the associated risks.

Fuel contamination (loss of fuel quality) is one of the main causal factors for engine failures and can lead to dual engine failures in twin engine aircraft.

FIRE AND EXPLOSION PREVENTION

Petroleum products are highly flammable. The risk can be reduced by removing or mitigating sources of ignition and using appropriate containers for transport and storage.

Sources of ignition such as a lit cigarette should be prohibited within any fuelling zone and at least 16 metres (50 ft) from any open fuel container or fuelling operation, especially downwind.

Other possible sources of ignition are sparks originating from exposed battery connections, operating electrical switches, metal studs on concrete, or electronic devices. Refuelling should not take place when there is a risk of lightning or other electrical activity.

You should have a suitable fire extinguisher available, preferably foam but not a domestic water type. Water is not effective against petroleum flames and will only make the fire worse. Ensure you know how to operate the extinguisher and any other safety devices such as rapid shut off valves on dispensing equipment.

Know how to contact the fire service if the worst should happen. No one should be in the aircraft during refuelling.

FIRE AND EXPLOSION PREVENTION

Prevention of static discharge

Static electricity can build up during fuelling, especially in cold and dry weather. A static discharge is a potential source of a spark and therefore ignition. To minimise the risk, electrical 'bonding' and/or 'earthing' is used to neutralise differences in electrical potential between refuelling components or the aircraft. This should ensure that static discharge sparks do not occur.

The term 'bonding' refers to connecting two or more potentially conductive components, for example the aircraft and metal parts of the fuel installation or dispensing vehicle. 'Earthing' refers specifically to connecting something conductive to the earth.

A fixed fuelling installation or other static container that is used for dispensing fuel should normally have an earthing wire to the ground. For example, for a fuel drum or large can, an earth can be made from copper braid, heavy duty crocodile clips and a ground stake. To ensure no discharge between the refuelling funnel or nozzle and the aircraft, there should also be a bonding wire that connects the installation or container to the aircraft.

When refuelling from portable containers, it is not usually necessary to have an earthing stake into the ground, but it is still important that any difference in electrical potential between container and aircraft is neutralised before fuelling commences. A bonding wire between the container and aircraft is recommended, but for small 'jerrycan' style containers it is normally sufficient to simply touch the container, funnel and the filling point of the aircraft together, before opening any filling caps. Doing so should neutralise any differences in electrical potential that might cause a spark.

When using a bonding wire, it is important to connect to unpainted metallic parts of the aircraft. On wood or composite aircraft, it may not be sufficient to use a component such as the engine, exhaust or undercarriage, since there may not be an electrical path with the fuel tank. Connecting to the fuel filler neck is normally sufficient, but check whether there is a manufacture recommended bonding point.

Containers, pipes, funnels and other components used in the fuelling process should generally be metal, except for portable plastic containers up to the permitted volume.

FUEL SPECIFICATION AND QUALITY

The aircraft and engine certification process involves testing using fuels that meet a certain specification. Once certified, the aircraft/engine approval is conditional upon the use of those fuels. It is therefore essential that personnel responsible for refuelling are aware of the approved fuel(s) for a given aircraft type and how to prevent any contamination that may render the fuel unsafe for use.

Pilots should be vigilant when refuelling, particularly at unfamiliar aerodromes, and ensure the fuel is the correct type and grade, particularly when JET A-1 and AVGAS are being dispensed from similar bowsers. For example, fuel suppliers may see a small propellor aircraft and assume that AVGAS is required, when it may in fact be equipped with a diesel engine.

If purchasing AVGAS (100LL & UL91) or Jet Fuel (Jet A-1) to be stored, the fuel supplier should provide the fuel to your storage facility at the approved specification and in a condition fit for use. You should obtain contact details to report any suspected problems with the fuel supplied. A small quantity of poor fuel will contaminate the whole container.

MOGAS

If using MOGAS (motor gasoline), be vigilant for fuel quality issues. Petrol sold for motor vehicle use may not have been subject to the same quality control and storage procedures as that produced specifically for aircraft.

MOGAS to EN228 standard may be used in aircraft if permitted by the engine manufacturer and having confirmed that the aircraft fuel system is chemically compatible with this type of fuel. For aircraft with a Permit to Fly administered by the **Light Aircraft Association (LAA)**, MOGAS must only be used in accordance with LAA Technical Leaflet (TL) 2.26 – 'Procedures for use of E5 unleaded and E5 super unleaded MOGAS'.

Even if approved for MOGAS, there may be operating limitations (such as altitude or air temperature) compared to the primary recommended fuel grade.

Until recently, petrol for motor vehicle use contained no more than 5% bioethanol, known as E5. However, the recent introduction of E10 petrol (containing up to 10% bioethanol) has potential implications for GA.

Owners and pilots of aircraft that currently use E5 MOGAS should not use E10 unless expressly approved by the engine manufacturer or relevant regulating body.

For more information on the use of MOGAS in light aircraft, owners and pilots should consult the **Light Aircraft Association (LAA)** and **British Microlight Aircraft Association (BMAA)**. The LAA TL 2.26 and the BMAA Service Bulletin 2695 issue 1 contain useful information for pilots and owners.

STORAGE AND EQUIPMENT

The Petroleum (Consolidation) Regulations 2014 limit the volume of fuels for internal combustion engines that may be stored at private premises. These are enforced by the relevant Petroleum Enforcement Authority (PEA), normally part of the Council or in some metropolitan areas of the UK, the Fire and Rescue Service. For more information, please consult the Petroleum Regulations or contact your PEA. The **Health and Safety Executive (HSE)** also provides further guidance.

The Petroleum Regulations allow private individuals to store up to 30 litres of fuel. This does not include fuel in the aircraft or vehicle fuel tank that supplies the engine.

There are also individual storage limits depending on the containers used:

10 litres in a plastic container

20 litres in a metal container

30 litres in a demountable fuel tank

If intending to store more than 30 litres of fuel you must inform your local PEA. Storage of more than 275 litres requires a licence from the relevant PEA. Note that dispensing fuel (even for private use) above the amounts permitted in portable containers also requires a licence.

It is permissible to transport limited quantities of fuel in a private road vehicle, provided it is in suitable containers and secured for transit. Always remove portable containers from a vehicle before filling them.

Aircraft fuel systems

The same principles of fuel storage apply to fuel left in the aircraft's tanks for long periods – particularly with E5 MOGAS you may find it deteriorates and damages the tank and/or fuel system, for example absorbing water and thickening. Avoid leaving unused fuel for long periods in the aircraft. It is normally better to keep aircraft tanks full, since this reduces the opportunity for condensation to form.

If starting an aircraft that has sat unused for a long period, the fuel system should be drained and refilled with fresh fuel. Consult a licensed aircraft engineer for further guidance if you are unsure as to the condition of the fuel system.

STORAGE AND EQUIPMENT

Storage and dispensing facilities

The following provides some general guidelines for the storage of fuel. If intending to store and/or dispense significant quantities, you must seek further guidance on storage and installation safety and have the appropriate licence from your PEA.

Any container or apparatus for storing or dispensing aviation fuel must be of a suitable type, specification and manufacture, and clearly marked with the grade of fuel it is intended for. Fuel hoses have a limited life and should be fitted within two years of manufacture. Once installed hoses should be regularly checked for condition.

To prevent contamination, the container and all parts such as hoses, seals and liners, must be of good quality materials that will not be affected by the fuel to be contained. Water should not be able to enter the container or any part of the fuelling system.

The fuel hoses and container must be kept clean, with no chance of having been contaminated by other liquids. For example, do not transport AVGAS in a jerrycan which previously contained Jet Fuel. Any filters should be cleaned and/or replaced following the manufacturer's instructions - ensure they are refitted in the correct orientation.

Fuel in contact with air will deteriorate over time - Condensation of water vapour inside a tank will contaminate the fuel below it. Fuel should not be allowed to remain unused in hoses for long periods – recycle the fuel through them every week if possible, ensuring the full volume of the hose is changed.

Containers must always be kept closed, and not filled above 90% to allow for expansion. Even in ideal conditions, stored fuel may degrade after a while. If fuel has been in undisturbed storage for more than three months, consider having a sample laboratory tested before using it (six months for Jet A1). Whilst much depends on the condition of the container and the atmospheric conditions during storage, the likelihood of significant fuel performance degradation is real. To minimise MOGAS deterioration, use freshly obtained fuel from a major supplier with a high turnover.

Financial considerations may encourage owners to keep stocks at a minimum during periods of inactivity. However, if levels in storage tanks are allowed to drop and remain low, the fuel at the bottom may depart from specification, affecting the quality of the whole tank when it is refilled. A full tank is less likely to suffer either deterioration or water contamination. When fuel consumption will be low, such as during winter, keep containers as close to 90% full as possible.

Environmental damage

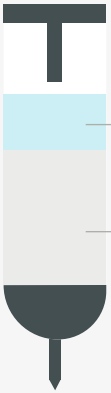
Fuel can damage the environment, so any leakage must be contained. A storage tank may have a double skin, the gap of which needs regular checking. Otherwise, a concrete 'bund', or bath which can hold the tank contents, should surround it. Consider how to minimise environmental damage from malfunctions such as a hose nozzle becoming jammed open. Know what immediate actions to take and who to contact in the event of a major spillage or leak from the tank.

SAMPLE AND TESTING

A vital part of any aircraft pre-flight is to sample the fuel for water and other contaminants using a sampling cup. Draw fuel from each drain or sump and examine it in accordance with the Flight Manual or Operating Handbook. Even aircraft in a hangar may suffer condensation inside the tank.

The picture illustrates the boundary between a considerable amount of water and the AVGAS. If you see no separation in the sample, confirm that the sample is all fuel rather than all water.

Consider how to dispose of the sample; small amounts of petrol poured onto concrete will evaporate, but tarmac may be damaged. Some aerodromes will have a waste container in which to discard fuel samples. Do not return samples to aircraft tanks unless they are completely free from contamination.



Fuel will separate to the top

If water is present, it will fall to the bottom

Storage samples

When using fuel from your own storage or other private dispensing facility, samples should be taken from the storage tank immediately prior to fuelling an aircraft – remember sampling is a legal obligation under ANO Article 220.

Samples should be taken from the lowest point of the tank, where water is likely to settle. If a drain or sampling cock is not available, a vacuum sampling pump (sometimes known as a 'thief pump') may be used to obtain a representative sample.

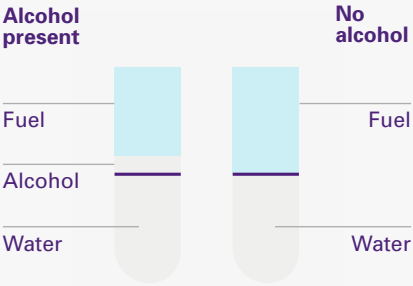
Samples should be clear and bright. Inspect them for water and contaminating particles. Consider water detection paste or papers. For Jet A-1, use water detection capsules which should be in date and stored in a dry environment.

A small amount of water can be expected, especially in colder temperatures when some condensation will form in the storage tank. However, if water remains after one or two samples have been discarded, suspect a failed seal or vent that is letting in water. Particles may indicate that the hose or tank lining is deteriorating, which may block filters.

SAMPLE AND TESTING

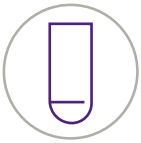
Testing for ethanol content

As noted earlier, some aircraft are approved to run on E5 MOGAS. However, this is not universal and particularly older engines approved for MOGAS may still require that it is completely ethanol free. It is still possible to obtain ethanol free MOGAS, but it is less common than in the past and it is vital that owners and pilots verify the lack of ethanol before use.

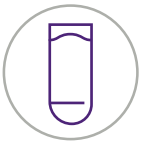


Note: The colour of MOGAS may vary

While commercial testing kits are available, testing for ethanol can also be carried out as follows:

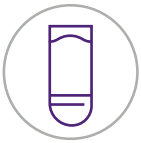


Obtain a clear tube (like a test tube or fuel drain device) and mark a line on it about 10% from the bottom.



Add water to the tube until it comes to the line. Now fill the tube with your fuel sample until it is near the top.

Shake vigorously for 10-15 seconds, let it settle, and if the separation point between fuel and water remains on the line, the fuel sample is ethanol-free.



If it is above the line (because the ethanol has mixed with the water) ethanol is present.

DISPENSING FUEL

If the refuelling service is provided by the aerodrome, check that the vehicle tanker or fixed bowser is delivering the correct fuel. If visiting a larger aerodrome where light aircraft are less common, be aware that fuellers may not be so familiar with light aircraft procedures – check that the operator connects the bonding wire to the correct location and that the fuel caps are secure after refuelling is finished.

For light aircraft with conventional over-wing refuelling points, a manual trigger operated or similar nozzle should be used. Automatic and/or locking nozzles are normally designed for high pressure delivery and should only be used on larger aircraft with the correct attachment point.

Bond the aircraft and all equipment before opening filler caps. Park the aircraft with brakes off so it can be moved away (preferably upwind) from any fire. Chock the wheels if necessary. Check the location of the fire extinguisher.

Fuel, especially jet fuel, can cause skin irritation, and fumes can affect breathing. The vapour displaced by the fuel entering the tank will descend, but also blow with the wind. Consider wearing anti-static protective equipment and clothing. Do not open fuel containers indoors.

If pumping from a fixed installation, follow the manufacturer's instructions. Devices designed to prevent over-filling and spillage are not always reliable. Nozzles can be damaged by scraping along the ground, and kinks can damage hoses. Ensure the area around the aircraft's filling point is clean and protect from water ingress.

DISPENSING FUEL

If dispensing by hand from a container, make sure the aircraft tank itself is bonded to the container and funnel, either by bonding wire, or from small containers, touching all the filling components and aircraft together.

When filling from a portable container, it is recommended to place a filter just before the fuel enters the aircraft tank. A chamois leather in the funnel should also absorb water. If the container is full, start pouring with the opening at the top to minimise splashing and loss of fuel. Re-check the bonding before opening a second container.

Spillages

A small amount of spillage may be expected. Small amounts on the ground will evaporate but larger spills must be cleaned up in an appropriate manner. If dispensing from a self-service installation or personal container at an aerodrome, notify the operator of the spillage. If you store and dispense your own fuel, you should have considered how to deal with spillages, for example having some suitable absorbent powers that will neutralise the fuel spill and stop it spreading.

Fuel-soaked clothing is a fire hazard, and even when dry may cause corrosive burning of the skin, so should be removed. Know where you can wash and change clothes.

Recording

It is a requirement for fuel installation managers (anyone responsible for storing fuel that is dispensed into aircraft at aerodromes) to keep records relating to fuel for use in an aircraft. If you dispense and store fuel you must comply with this requirement.

It is recommended that pilots keep a record of all fuel purchases, particularly if purchasing MOGAS. By recording where and when fuel was obtained, as well as the type and quantity received, the source of any problematic fuel batch can be more easily identified.

Further Reading

> Article 220 of the **ANO 2016** contains the regulations concerning aviation fuel at aerodromes.

> **Petroleum (Consolidation) Regulations 2014**.

> **Light Aircraft Association (LAA)** Technical Leaflet (TL) 2.26 regarding procedures for use of E5 unleaded Mogas to EN228.

> **British Microlight Aircraft Association** Service Bulletin 2695 issue 1 regarding fuel system damage due to use of MOGAS containing ethanol.

> **Joint Inspection Group (JIG)** Standards for Aviation Fuel Quality Control and Operating Procedures.