Tel: 263-4-251030/7 Fax: 263-4-791802 E-mail:ais@caaz.co.zw Website:www.caaz.co.zw	**CIVIL AVIATION AUTHORITY OF ZIMBABWE** **AERONAUTICAL INFORMATION SERVICES** P.BAG 7716 CAUSEWAY, HARARE	**AIC** **B004/01** **26 MAR 2001**

AERONAUTICAL INFORMATION CIRCULAR

AIC No B006/94 is hereby replaced

Aircraft fuel systems

As fuel system contamination and mismanagement continue to be a major factor in aircraft accidents, the following points are worthy of attention:

1. Refueling

Aviation petrol is coloured to indicate different octane ratings, however, aviation kerosene (paraffin) is not coloured. In spite of this cases still occur where the wrong grade of fuel is put into the aircraft tanks and in some instances kerosene is added to tanks containing petrol.

2. Water contamination

All aircraft fuels can contain water to some extent. Fuel supplied by the main oil companies from their own depots and in bowsers is carefully tested before delivery. However, fuel stored in drums is prone to contain water and should be carefully checked prior to use in accordance with the detailed instructions issued by the companies.

3. Pre-flight Inspection

Water can enter fuel tanks in 3 ways;

i) in water-contaminated fuel,

ii) through leaking tank caps in heavy rain,

iii) due to condensation on the inner surfaces of tanks under conditions of low temperature.

3.2 The pre-flight inspection must include a careful check of the fuel system and enough fuel should be drawn from the tank drains into a clean transparent container and the following checks made:

a) Correct colour (water may be slightly tinted if contaminated)
b) Smell i.e. petrol or paraffin also petrol evaporates rapidly.
c) Correct feel when rubbed between the fingers (paraffin has an oily feeling)
d) Water content a few water globules lying at the bottom of the container are acceptable but be on the alert for a sample of water only.

e) Foreign matter. This should be identified.

3.3. In some cases where fuel has been stolen from drums and aircraft tanks, deficiencies has been made up with water to avoid detection.

4. Fuel amounts

The surest method of checking the contents of an aircraft fuel tank is by using a dipstick or similar device. Fuel gauges cannot be relied on to give an accurate indication, and should only be used as cross-check. Where more than one tank is to be refuelled, care must be taken that the individual tank contents are balanced; asymmetric fuel loading may make an aircraft unsafe to handle, especially on take-off.

5. Fuel line aeration

Aeration of a fuel line can cause engine stoppage. For certain types of aircraft, instructions are published regarding the minimum fuel amounts and for fuel usage procedures so that under all conditions of flight, including fast turns, on the ground and uncoordinated manoeuvres in the air, fuel 'sloshing' cannot cause fuel line aeration. Pilots must be aware of these limitations.

6. Fuel usage in flight

Whilst it is not good practice to run aircraft fuel tanks dry in flight due to the attendant difficulty of restarting the engine, on occasions this may be required and the pilot should therefore know how to act in this situation. Be on the alert for unexpected cutting, bearing in mind that power restoration may take ten seconds or more, particularly with hand-operated pumps in certain types of older aircraft. Other risks include propeller over speeding.

7. Fuel measurement in flight

Fuel gauges should not be relied on in flight as the sole means of indication of the fuel available. Always crosscheck the residual fuel be subtracting fuel consumed (calculated with the aid of flowmeters if available).

With selective fuel gauges, care must be taken to see that the gauge selected corresponds with the tank in use. Certain systems are subject to unintentional cross feeding in flight, careful in-flight checks will show up such a fault.

8. Tank selection

Incorrect tank selection continues to be a common cause of accidents. Therefore, selection should always be double-checked and a selection should never be made just prior to take-off.

9. Minimum fuel amount in flight

With each type of aircraft and for each operation, the pilot establish a safe minimum amount of fuel for flight and ensures that the quality is not allowed to be below this at any time. This is particularly important for aircraft engaged in repeated take-offs and landings, and aircraft engaged in spraying operations.

10. Failure to obtain power on overshoots

There have been recent accidents caused as the result of forced landings following failure to obtain power when opening the throttle for an overshoot after a practice forced landing or similar exercise. When the engines were subsequently run on a test bench no defects could be found and the engines responded normally.

In such cases it is not usually possible to determine why the engine failed to respond. However, the most likely reasons are carburettor ice, an excessively rich mixture causing plug fouling or a combination of the two.

Engine manufacturers recommend that carburettor heat is to be used during an extended glide and this should be done. However, it must be realised that with throttle closed little heat is available to melt any ice which may have formed in the carburettor. Also, at the high density altitudes experienced in Zimbabwe there is a tendency for a rich mixture to exist and the use of carburettor heat richens the mixture even further.

The time to find out whether or not the engine will respond to throttle opening is at a safe height when appropriate action can be taken. All concerned are most strongly advised to open the throttle periodically during any prolonged glide to check for a normal response. This is standard but investigations have shown that it is not always being carried out.

11. Carburettor ice

Carburettor ice, can and often does, cause engine failure without warning. It may form in clear air at high temperatures under conditions in which structural ice could not possibly form. If the relative humidity of the outside air being drawn into the carburettor is high, ice can form inside the carburettor in cloudless skies and with the temperature as high as 25°C. It is most serious when the temperature and the dew point approach 20°C but pilots should be alert for it at any time the relative humidity is high. It sometimes forms with outside air temperatures as low as -10°C.

Carburettor ice forms during vaporisation of fuel combined with the expansion of air as it passes through the carburettor. Of the two cooling processes vaporisation of fuel causes the greater temperature drop which may amount to as much as 40°C but is usually about 20°C. The temperature drop is very rapid and can be a second or less. Due to the temperature drop the air cannot hold all the moisture contained in it in vapour form and this moisture condenses out into visible water droplets. These water droplets will freeze if the cooling is sufficient to bring the temperature inside the carburettor down to 0°C or colder and ice will form in the carburettor passages. This ice may form at the discharge nozzle, in the venture on and around the butterfly valve or in the curved passages from the carburettor to the engine.

The carburettor heat is an anti-icing device which preheats the air before it reaches the carburettor, melting any ice and keeping the temperature of the mixture above freezing point. The heater is usually adequate to prevent icing, but it will not always clear out ice which has already formed. During prolonged glides or descents at very power the temperature of the engine exhaust system, from which by means of a muff device obtains its source of heat, may fail to a value which is insufficient to heat the air entering the carburettor to a level to melt the ice. It is therefore essential that the throttle be opened periodically to keep the engine warm.

Use of the carburettor heat tends to reduce engine power output and to increase operating temperatures. It should not therefore be used during take-off under any but the most severe icing conditions. It must however be remembered that periods of pre-take-off taxing at very low power may give rise to carburettor ice before take-off, carburettor heat should be used to clear any ice which may have formed. Carburettor heat should be used during taxing but pilots should ensure that this procedure is permitted in their particular aircraft as on some installations the heater air is unfiltered and its use under dusty conditions may have an adverse effect upon engine wear.

To summarise:

i) Ensure that the carburettor heat control is functioning before take-off.

ii) In-flight, be alert for carburettor ice particularly when the humidity is high. In Zimbabwe this applies mainly from October to May but carburettor ice is far from unknown at any time of the year.

iii) Do not use carburettor heat for take-off unless absolutely necessary but be sure that any ice which may have formed during taxing is cleared before take-off.

iv) Do not wait until ice has formed before using carburettor, preheat to prevent ice.

v) If ice has formed apply full carburettor heat and obtain as much power as possible. Do not expect the ice to be cleared immediately you apply heat, rather expect an initial fall off in power until the ice has been cleared. This may take up two minutes or even longer.

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