Cessna 150 Safety Review Part 2

By Brian Lowe

January's article revealed how the Cessna 150 had over three times the number of fatal accidents' per hour flown compared to the Cessna 152. Despite both aircraft having the same type certificate and being very similar in appearance and performance, the accident profile of the Cessna 150 is radically different with far greater numbers of accidents being attributed to fuel starvation or carburettor-icing. To understand the causative factors it's necessary to closely examine the 150's design and development. .

Fuel System

The fuel venting system of the Cessna 150 is such that when the tanks are full or when the aircraft is banked at a steep angle, fuel can decant from one tank into the other resulting in a fuel imbalance between the tanks. Flying the aircraft out of balance can have a similar effect. Post accident investigations have shown that as much as 12 Litres extra can be in one tank compared to the other which can result in one tank running dry and sucking in air while ample fuel remains in the other tank. This problem is most evident in aircraft that have been engaged in aerobatics, or flight training involving circuits or steep turns.

The 140 originally had independent left and right tanks with the feeding tank being selected by a Left-Right fuel valve. Each tank had its own vented fuel cap. In later models the fuel selector valve was modified to allow fuel to also flow from "Both" tanks. A cross vent between the two tanks was also added.

When designing the 150, Cessna decided to dispense with the left and right fuel flow selections and designed the fuel system to constantly feed from both tanks. The cross vent was retained and a vent tube was added to the left wing, venting the left tank while the right tank retained the vented fuel cap.

The decision to install a modified version of the 140's fuel system in the 150 created a number of unintentional side effects.

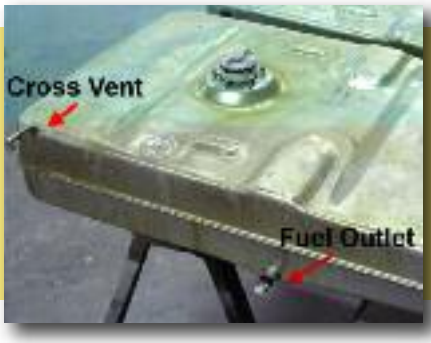
The 140's fuel drains were located at the rear of the tank which sloped naturally rearwards in its tail-wheel configuration allowing any residual water to be drained from the tank. However the 150's nose wheel configuration meant that the tanks in the wings were flat and level allowing water to remain undetected in the centre of the tank as the fuel drain was positioned at the rear.

The requirement to give the 150 a modern facelift led Cessna to discard the 140's mechanical fuel gauges (located in each wing) in favour of the new electric fuel gauges and sender arms that are now widely regarded as being inaccurate and unreliable.

The 150's fuel venting system is subject to complex pressure imbalances and vacuums which can alter or even stop fuel flow from a tank. The lack of ability to individually select the feeding tank, (a feature on all other Cessna's) creates the possibility that a fuel imbalance will result in one tank running dry and letting air into the fuel system with potentially disastrous consequences.

Unusable Fuel

The type certificate of the 140A states its unusable fuel is 2 US Gallons



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per tank. It seems strange therefore; that the Cessna 150 which has the same fuel tank construction should have a lower (1.75 USG) unusable fuel quantity than the 140, particularly as the 150 has a far steeper nose down angle during descent with full flaps deployed.

FAR 23 and EASA CS23 define unusable fuel as the quantity at which the first evidence of malfunctioning occurs under the most adverse fuel feed condition occurring under each intended operation and flight manoeuvre involving that tank.

The Cessna 150 however was certified under earlier US Civil Air Regulations CAR 3 which has a very multifarious method of deriving unusable fuel and in accordance with CAR 3 it was determined that the 150's unusable fuel was 1.75 USG per tank.

Tests conducted by the Irish Air Accident Investigation Unit in 1999 following the crash of Cessna 150 EI-AUC determined that a Cessna 150 with 40 degree Flap deployed in approach configuration had an unusable fuel in excess of 2.11 USG which is 20% higher than that derived under CAR 3 and published in the 150's TCDS (Type Certificate) and POH (Pilot Operating Handbook).

The AAIUs analysis suggested that the aircrafts real unusable fuel is at least 0.72 USG (2.75 Litres) greater than that stated or 8 minutes less flight time, redefining the Cessna 150s actual unusable fuel figure as 4.22 US Gallons (or 16 Litres) - a massive 17% of total tank capacity.

This inconsistency in the Cessna 150's unusable fuel is of great concern. Which figure should pilots be using? - the FAA published 13.25 Litres or the AAIU figure of 16 Litres. At the very least the authorities need to re-test the C150's fuel tank using FAR23/CS23 standards and publish the correct figure.

Accident Case Study - Scenario No. 2

For the past ten years the pilot and his companion had attended a Fly-in weekend, 220 miles from their home airfield. On the night before they departed the Fly-in, their Cessna 150 was parked on a slightly downward slope. The pilot fuelled the aircraft, fully filling the right tank then the left giving a total useable fuel quantity of 85 Litres. Early the next morning they prepared for departure. The weather forecast was good with a light headwind. The pilot estimated, that if flying at cruise speed of 90 kts and allowing for a 10 kt headwind, the trip should take 2 Hours 45 minutes consuming 61L of fuel (at 22L per hour) with fuel for over one hour in reserve. Having filled the tanks the night before, he neglected to dip the tanks opting instead to rely on the fuel gauges.

They departed early in the morning and the flight was uneventful except the headwind was stronger than expected and their speed over ground was reduced to 70 kts. The pilot recalculated their flight time as 3 hours 10 minutes and was confident they had 30 minutes in reserve. They approached their home airfield the fuel gauges read just under 1/4 in the left tank and 3/8 in the right tank although the pilot noticed that the right gauge hadn't moved in the past 30 minutes.

The pilot conducted an overhead join at 1500 ft and joined left downwind, turned base and lined up on final. The downwind fuel checks showed 1/8 in the left tank with the right tank still showing 3/8. On final there was a 15kt headwind with 5 kt crosswind from the left so he dipped the left wing slightly to hold the centre line and deployed full flap for landing. While on short final the engine spluttered and died. The pilot attempted to stretch the glide but was unable to do so with 40 degree flap deployed. The aircraft crashed into the boundary fence just short of the threshold.

Points to note:

If the 150's tanks are filled to maximum capacity, fuel will decant from the fuller tank into the other through the cross vent lowering the fuel quantity in the fuller tank. It is necessary to top up the tanks a second time to ensure both tanks are completely full.

If the aircraft is parked on a slope with left wing slanted down the slope, fuel can gradually drip out through the fuel vent tube and a significant amount can be lost over a period of a few hours.

It is essential for the pilot to dip each tank immediately prior to take off and to monitor and log fuel consumption throughout the flight.

It is preferable to use a fuel consumption figure of 25 Litres per hour in fuel calculations as it offers a greater safety margin should the aircraft be flown at a higher power setting.

The fuel gauges should be monitored carefully for irregularities during flight and appropriate action taken.

If any fuel gauge indicates less than 1/4 the pilot should regard it as a potential low fuel -emergency situation.

If the pilot suspects that the 150 is very low on fuel they should fly a higher than usual approach and be prepared to make a glide approach if necessary. The approach should be flown (where possible) with wings level and flap (in particular Flap 30 or 40) should be avoided until the pilot is certain they can safely glide to the threshold should the engine suddenly stop.

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Inaccurate and unreliable Fuel guages

In 1996 the US NTSB (National Transport Safety Board) highlighted a growing problem of inaccurate fuel gauges of the type installed in the Cessna 150, being a factor in many fuel exhaustion accidents. They highlighted the requirement that "fuel gauges must be accurate" and recommended that "Periodic recalibration of the fuel gauges should take place as it is the only way to ensure accurate fuel quantity readings". The FAA inexplicably trivialised the NTSB's findings and rejected their recommendations.

Over the years the manufacturers and the FAA have introduced a requirement that the fuel gauges be checked at each annual inspection but this check only requires that the fuel gauge be calibrated to read zero when the usable fuel is depleted but does not however require any further checks for accuracy other than to indicate Full. It's therefore possible that a gauge can indicate Full when the tank is only half full.

As a minimum, the calibration should be required to verify that the gauge is accurate across its full range at the indicated positions of Empty, 1/4, 1/2, 3/4 and Full.

In 2007 the South African Authorities responding to a series of C150 fuel starvation accidents issued the following direction.

"This aircraft (Cessna 150) should under no circumstances be flown with fuel tanks indicating 1/4 tanks or less. This is to prevent unforeseen engine stoppage during flight due to fuel starvation that could occur during prolonged uncoordinated flight, including skids, slips and unusual attitudes."

Ironically this mirrors advice given sixty years earlier in the 1948 Cessna 140's Operations Manual (POH) which states, "Do not take off on less than 1/4 tank"

The UKs GASIL has also advised "that the fuel gauge with the lowest reading should reflect the aircrafts total fuel state". (paraphrased)

Next month I hope to examine a range of modifications that can mitigate the risks posed by the Cessna 150's design, however pilot education into the aircrafts characteristics remains the best way to avert accidents. It's important to remember that many of the potentially dangerous characteristics attributed to the Cessna 150 can equally apply to other aircraft particularly those certified under CAR 3.

As always I greatly appreciate any comments on this article..

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