Clued up

GA Update

February 2021

WEIGHT & BALANCE

UK Civil Aviation Authority

WEIGHT-WATCHING

It can be easy to become complacent about weight and balance checks over time, but excess poundage can creep up on anyone

"So, there's a course near the hotel… let's take the golf clubs, should get a game or two in during the week; it's a four-seater so we'll be okay with full fuel as it's just the two of us." Really, are you sure?

How much does a set of clubs weigh? — the average is 30lb/14kg, so that's around 28kg of extra weight and what about any extra luggage, and is the aeroplane really a true four-seater or more of a 'two-plus-two'?

There are few genuine four-seat aircraft that can carry four adults, some limited luggage and enough fuel for a two-hour flight plus reserves. And that's assuming the adults average out at 12 stone/76kg — perhaps a bit of wishful thinking there in some cases…

Are the passenger weights really correct; are they when fully clothed or just after getting out of the shower and before breakfast? What about the mobile phones, tablets and any other electronic equipment being carried? They might only be a few ounces/grams but it all adds up to lots of lbs/kgs. It's a good idea to allow about 9lb/4kg extra for each person's ancillaries. Then there's the headsets and how much does your packed flight case actually weigh — you get the picture?

The Aircraft Flight Manual (Pilot's Operating Handbook) might indicate a useful load of XXXX but that's for a basic aircraft — if you check the actual Weight & Balance Schedule, with all the avionics and other extras the useful load is likely to be considerably less.

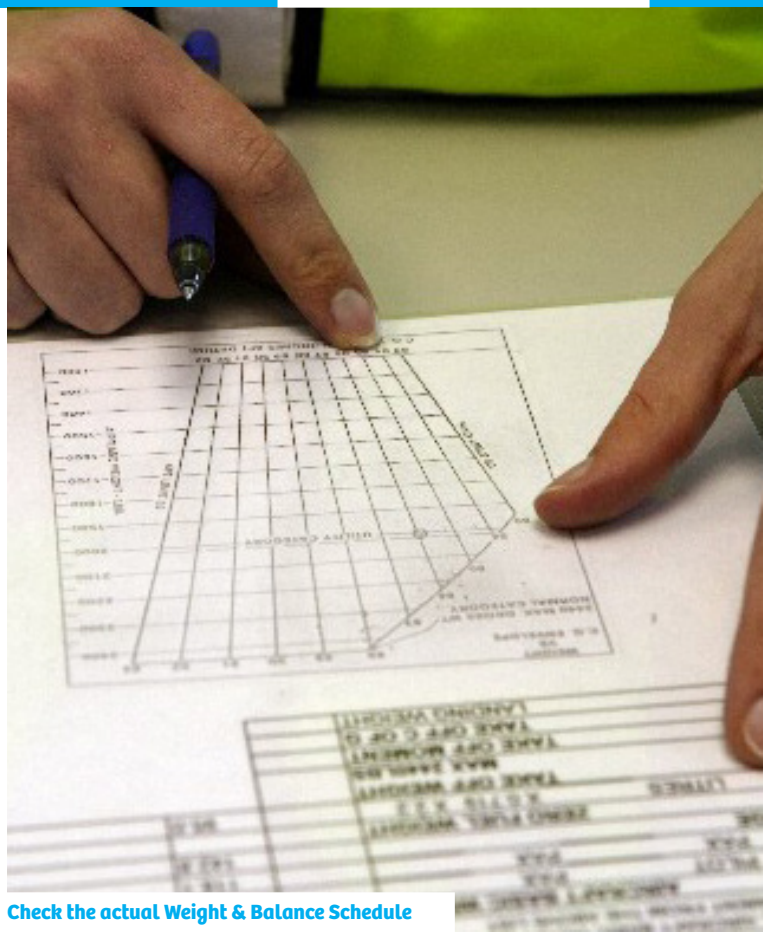
Here are a couple of examples of common four-seater aeroplanes with standard fuel tanks; in a well-equipped Cessna 172 with full fuel you could have just 510lb/230kg for pilot, passengers, flying kit etc; a PA-28-181 can be slightly better allowing you to carry around 630lb/287kg.

Then there are the LSAs which have a maximum all-up weight of just 600kg/1320lb (land); taking just the basic aeroplanes with full fuel and without any extras, a SportCruiser for example will carry 340lb/156kg; a Breezer will take 385lb/175kg and the Eurofox is somewhat better with a carrying capacity of 450lb/205kg.

So, what if the aircraft is a few pounds overweight? Well, for starters the flight would be illegal and a potentially prosecutable offence, the insurance would be invalid and you'd need to consider how its performance would be affected, especially the take-off distance: A 10% increase in aircraft weight increases take-off distance to clear a 50ft obstacle by 20% — but that certainly doesn't mean 10% overload above Max Take-Off Weight is okay if you have a very long runway, and some low-powered aircraft wouldn't even take off at all if 10% overweight.

Think back to the hot summer weather we had this year with temperatures in the high 20s to low 30s; an increase of 10°C in ambient temperature increases the take-off distance by a further 10%. Then

How many can you really carry?



Check the actual Weight & Balance Schedule

there is, perhaps, the effects of grass, uphill slope, tailwind etc — and these effects are cumulative (and the landing distance will be affected as well).

And here's another thought, where will that weight be inside the aircraft? Not only do you have to be within limits, but where you put the weight in the aeroplane is equally as important to ensure you're within the centre of gravity limits for take-off and landing. As you burn fuel the centre of gravity will move. The position and movement of the centre of gravity can be particularly critical in some of the six-seater singles (PA-32, Cessna 206/210, for example) so it's worth checking the calculations very carefully.

C of G can be particularly critical in six-seaters

Not correctly determining the aircraft weight and balance and attempting to operate significantly overweight can and has recently led to a GA aircraft accident in which occupants were injured. Operating in this way can also lead to a prosecution and conviction of the pilot.

Another incident, that could have been horrific, had just the pilot on board — attempting to get a Cherokee airborne out of an uphill grass strip on a very hot calm summer's day he just got over the hedge, but then hit a keep left bollard at the beginning a dual-carriageway narrowly missing a petrol tanker coming from one direction and a coach full of passengers from the other way; the aircraft ended up coming to rest on a wall on the other side of the main road. Although it wasn't overweight, that particular aircraft was not designed to get airborne in those conditions. He was prosecuted, and his Instructor's Rating taken away.

Weight & balance issues don't just happen during take-off (and landing…); a pilot in an overweight Rallye decided to do some aerobatic manoeuvres, which it's cleared for when operated to the reduced Utility category limitations, but when he landed his wings had rippled so badly they looked like corrugated iron. It was a write-off, and not surprisingly the insurance company refused to pay out and one very innocent, and understandably angry, co-owner was left drastically out of pocket, as was the pilot concerned.

All the principles mentioned for fixed-wing aircraft also apply to rotary-winged aircraft so we'll try not to be repetitive, just add a bit of context.

While it's relatively straightforward to address centre of gravity and weight & balance issues with individual pilots ➤

Lighter helicopters absolutely need proper calculations

Some LSAs need particular care over weight

directly in relationship to the aircraft to be flown and the intended mission, it's more difficult to generalise as there are many factors that affect the aircraft's primary function, the ability to take off and land vertically, especially when operating in a confined area.

As with fixed-wing, seemingly identical aircraft may fly very differently and many predetermined and variable factors can all have an effect; for example, how it's equipped and configured, how many paint jobs, the weight and even the shape of the pilot.

Take a range such as Robinsons, Cabris, Schweizer H300s, JetRangers and Squirrels; in addition to correct distribution of passengers and equipment/baggage, some aircraft might need to carry ballast at times to ensure they stay within the envelope for the whole duration of the flight. Therefore, pilots can't afford to be complacent about centre of gravity et al, even when flying a favourite aircraft on a familiar profile.

Bearing in mind that rotary-wing flight is generally more expensive than fixed-wing, PPLs and students tend to fly the more economical aircraft where there is less margin for error, especially on machines with low inertia rotors. Consequently, the need for proper calculations to be completed before each flight cannot be overemphasised. The comment made about the pilot, in particular, stems from the fact that, as fuel is burned and the helicopter becomes lighter, depending on the model and other factors, the machine might start to fly nose or tail down.

In a nose down configuration a, shall we say 'more rotund' pilot, might not be able to get sufficient rearward cyclic to slow the helicopter down and bring it to the hover (stick in stomach!). And while a run-on landing is possible in 'normal' trim, attempting to run-on nose down is far from ideal.

Operating above maximum weight will affect the handling (assuming you can get airborne at all), especially in more challenging flying conditions where additional load factors are more likely to compromise the structural integrity of the helicopter. This might not be immediately apparent but stressed components may be found, at best, during routine maintenance, resulting in tens of thousands of pounds in repair bills, or, at worst, lead to a critical component failure in flight.

Being overweight stresses drive, transmission, gearbox and rotor components and, whereas the loss of some drive constituents may be survivable if there is sufficient control to make a successful forced landing, other structural failures might not result in a satisfactory outcome.

Equally, flying underweight can change a helicopter's handling characteristics and controllability to the extent that flying solo in a helicopter such as an R44, which can require a large amount of forward cyclic to maintain a hover, might not be possible without additional ballast.

Many helicopters have minimum seat and overall weight parameters which, where necessary, can be met by carrying ballast. Adding ballast appropriately also helps neutralise the position of the cyclic stick allowing greater directional control and will improve auto-rotational characteristics by establishing the descent sooner and ensuring that the required rotor rpm can be established and maintained throughout. ■

IN SUMMARY

- **Obtain the actual (not typical) empty weight and centre of gravity of the individual aircraft you are going to fly from its latest Weight & Balance Schedule.**
- **Check that the maximum take-off weight is not exceeded. If it is, you must reduce the weight by off-loading passengers, baggage, or fuel.**
- **Check that the C of G is within limits before take-off and will remain so throughout the whole flight including the landing. If it doesn't stay within the approved range, you must change one or more of the following:**
  - **– The position of baggage or cargo**
  - **– The allocation of seats according to passenger weight**
  - **– The fuel load and tank position**
  - **–And the planned type of flight**
- **Before certain manoeuvres (spinning or aerobatics, for example) check, and if necessary, act upon any weight or C of G range restrictions.**
- **Don't forget the effect of weight changes on runway length requirements and safety factors, see Safety Sense Leaflet 7, Aeroplane Performance, and Safety Sense Leaflet 9, Weight & Balance.**

Finally, always check — never consider flying an aircraft outside the permitted weight and C of G range.