

## Probably the most feared flight condition - Martin Bedding takes preventative measures



By definition, the stall is a condition whereby the angle of attack increases to a point where lift begins to decrease ('angle of attack' is the angle of the wing leading edge in relation to the horizontal). It's not only at a low power setting when a stall situation will occur, it can happen at any power setting, even full power if the angle of attack is increased beyond the point of lift. For example, it's possible to experience a power stall in a (full-size) light aircraft, whereby the nose of the aircraft is raised and at the same time power applied; continue to pull back on the elevator, and at a given point the nose will drop away very abruptly. If you want to experience this situation for yourself, make sure you have an experienced pilot at the controls and are at a point several thousand feet above the ground. The same experience can be replicated with a model. Again, if you're going to try it (it's not a bad thing to experiment with), be sure to have sufficient height, and reduce the power as the nose drops. As I've stated in past articles, fly two mistakes high until you're familiar with your model's handling characteristics.

Now, you may have seen aircraft at displays flying slowly, with a nose-high attitude. Termed 'high alpha', this seemingly risky manoeuvre looks very impressive, and whilst it might appear that the aircraft is close to stalling, there's actually no problem because ample power applied. A full-size F-16 flying slowly down the flightline in high alpha looks really impressive, but do remember that the flight controls of the F-16 are computer-controlled; it wouldn't be possible to perform the same manoeuvre with a Cessna 150, for example.

## CAUSE & CONSEQUENCE

Everyone who flies a model or full-size aircraft actually experiences a stall every time they fly, that is, if they're flying correctly. Every time an aircraft lands, if the airspeed is right, it should land at the point of the stall. However, in many cases a stall results in the model crashing, often because the pilot doesn't understand what's happening or, for that matter, why it's happening. For example, if an aircraft is in a banked turn of, say, 60°, the stalling speed can increase by as much as 40%. The steeper the angle of bank, the higher the stalling speed will be. So, if the aircraft is on a base leg for landing, the final turn should be kept as shallow as possible to prevent the model from spinning into the ground, especially if it's a small, heavy model with a high wing loading. As a model pilot, how often have you made that final turn to line up with the runway only to find the model spins into the ground for no apparent reason? Let's go through what actually happens during the landing phase.



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*The approach is nice and slow, everything looks great, then, all of a sudden, a wing drops and the model falls out of the sky. But why?*

The model loses height and the throttle setting is low as you make the final turn to line up with the runway. Ailerons, elevator and (maybe) rudder are applied, and since this is almost the same combination used to induce a spin manoeuvre, if you're too slow, a stall-induced crash is likely to follow. Some pilots land far too fast in order to avoid this situation, but if you check out your model's low-speed handling characteristics beforehand, at a safe height, then low-speed crashes and fast landings can be avoided. I don't know why some pilots are afraid of checking out the slow speed handling qualities of their models? Many never assess this and rely solely on landing well above stalling speed. However, this increases undue stress on the airframe and in a short time the model may start to fall apart - internal joints become loose or broken, and u/c mounts start

to break away.

I'm sure some of you must have experienced this next situation. The model's lined up perfectly with the runway, the approach is nice and slow, everything looks great, then, all of a sudden, a wing drops and the model falls out of the sky from about two or three metres... The dreaded tip stall... Crunch! Anyone who's experienced this situation will know this happens without warning, and certainly catches out the unwary.

## PREVENTION

Pretty bad news, this stalling, so what can be done to prevent it? Well, you can't prevent it as such, but things can be done to make it less dramatic and more pilot-friendly. First and foremost is weight. The lighter the aircraft, the lower the stalling speeds will be and it will also be more predictable. If you build from a plan or kit then you have the chance to incorporate some weight reduction, but what about ARTF models? Truth is, the pre-built nature of the major assemblies means there's not much you can do. If there are any exposed wooden parts, you could consider drilling some lightening holes, providing the airframe's integrity isn't compromised by doing so. That said, the manufacturers of many modern ARTFs have cottoned on to the fact that lighter models fly better and already incorporate weight reduction into their airframes.



*Power, light weight and large control surfaces are everything when flying in high alpha.*

Okay then, so our model is nice and light, but it still tip stalls. Why?

Warps and twists. Check that the wings are straight and true. If the aeroplane always drops the same wing, it could be that a badly warped panel is to blame. And don't assume that this can happen only with a kit or plan-based model, it's not unknown for ARTFs to suffer the same problem. Whatever the basis of the model, make sure it remains straight and true during the build with no warps or twists. And take care post-build too, as extremes of temperature and humidity can also cause warping problems.



*Highly tapered wings, especially those on scale models, benefit greatly from a small degree of washout*

Lateral balance. If everything's nice and straight, then try laterally balancing the model. If one wing's heavier than the other, the heavy wing will drop every time. So, try adding some weight to the light wing.

Washout. If you have a scale model with a wing that's highly tapered towards the tip, said wing should have some degree of washout built into it. Washout is where the wing's trailing edge is twisted up at the tip relative to the root, which creates more lift at the tip. If the wing is twisted the other way, creating wash-in, this will add to the tip stall problem. If such a wing is perfectly flat, with neither wash-in nor washout, then raising both ailerons slightly (about 2mm) will help a great deal towards preventing tip stalling. However, bear in mind

that when the model is inverted you'll then in effect have a wash-in condition, making slow, inverted flight interesting to say the least!

Stall strips. Fitted to the wing i.e., these will also help to reduce severity of the stall. Stall strips are short lengths of triangular material fitted right on the front of the i.e. at the root position of the wing. They work by deliberately disturbing the airflow at the centre of the wing, making it stall before the tip, which in turn reduces tip stalling. A really good example of these can be found on the de Havilland Chipmunk, which has triangular pieces of aluminium riveted to the i.e. (I think they're about 600 - 900mm long).

## TIP TALK

Almost all modern day aerobatic aircraft have flat, square wing tips, which look almost unfinished. The reason for this is to actually make the aircraft stall more easily; this may seem odd, but don't forget that an aerobatic machine needs the ability to spin and snap roll easily. Such tip design has to be carefully controlled; a fine balance between being too stable and too unstable. If the wing's thicker at the tip than at the root, this will help to reduce tip stall characteristics, because if the wing is deeper the airflow speeds up and thus increases lift.



*Modern aerobatic aircraft have flat, square wing tips to help them stall more easily!*

## FENCED OFF



*Wing fences stop air spilling out along the wing, which helps to improve the stall characteristics.*

Take a close look at some modern jet aircraft such as the BAe Hawk. Along the top of the wing surface you'll notice a fence protruding by about 50 - 60mm; this is to prevent air from spilling out along the wing. The fence keeps the airflow in place to aid flight and help prevent stalling.

I know of at least one full-size aerobatic aircraft (Raven) that has fences fitted to both inboard and outboard ends of the ailerons, effectively increasing the area of the aileron and, consequently, increasing the roll rate. The Raven also has fences fitted to its wing tips, again to stop air from spilling off the end. Similarly, some large passenger aircraft have what are called winglets at the tip of the wing, this being a turned up section that, as before,

stops air from spilling out. It also increases the wing area at the tip.

We've established that fences help prevent tip stalling, but surely, an aerobatic aircraft should be able to tip stall? True, and since the tip fences have effectively increased the wing area the total wingspan can be reduced slightly, thereby reducing the roll inertia and making rolls and point rolls more positive, this coupled with very precise handling.

## BRIEF ENCOUNTER

That concludes our quick look at the stall. There are a number of other options available to aircraft designers to help improve stalling characteristics: flaps, i.e. slats, air brakes... the list goes on. However, no matter what devices are employed, in the end it all comes down to knowing the capabilities of your model. Experiment with airspeed and angle of attack at a safe altitude and you'll begin to learn the model's slow speed handling qualities, which in turn will make you a better, safer pilot.

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