

The Risks of Maneuvering Speed Myths – Part 3

We're now going beyond the scope of the original Avweb article at

<http://www.avweb.com/news/features/The-Risks-of-Maneuvering-Speed-Myths222680-1.html>

After dangerously, incorrectly describing V_A , CASA's CAAP 155-1, Aerobatics, goes on to make this useless statement:

"Full control deflection of any flight control should be avoided above this speed."

Let's explore this statement in the context of the full definition of Maneuvering Speed provided in Part 2. Recall that Maneuvering Speed is the maximum speed at which we may move a single control to its maximum etc. To state that we should avoid full control deflection above this speed is true but useless in that it does not explain how much control deflection may be applied. Logically, just a little above Maneuvering Speed we could apply almost maximum and less as airspeed increases until Never Exceed Speed when we might expect to be able to apply very little control, perhaps none? The answer, of course, is in FAR 23.

The use of the elevator control is fairly straightforward and we have an instrument to measure the result – the accelerometer. Pull the stick back suddenly and we get some G. We know that FAR 23 requires that the aircraft be designed for sudden maximum elevator movement at Maneuvering Speed. It goes further to require, above Maneuvering Speed, sudden back stick movement followed by a forward stick movement so that the maximum allowable G is not exceeded. So, as long as we don't exceed the maximum G we can do what do pretty much what we like with the elevator above Maneuvering Speed? We will come back and look at this point again later.

Para 23.455 refers to the use of ailerons:

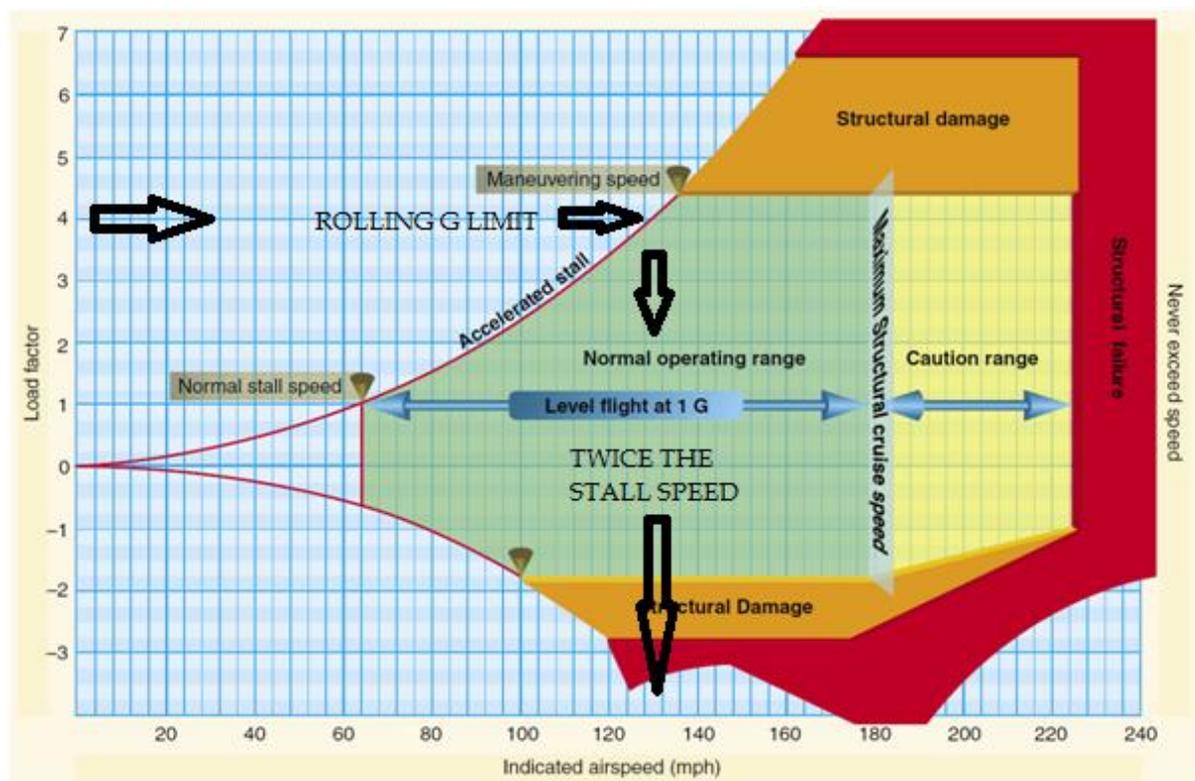
- Sudden maximum displacement of the aileron control at Maneuvering Speed – we knew that already.
- Sufficient deflection at Maximum Structural Cruise Speed to produce a rate of roll not less than that obtained above – fairly clear isn't it – it does however require some judgement by the pilot as we don't have an instrument in front of us to tell us what the roll rate is. I note that Decathlon pilots, at least, should already know this as the Flight Manual clearly explains this same limitation.
- Sufficient deflection at Design Dive Speed to produce a rate of roll one third of that obtained by maximum aileron at Maneuvering Speed. Never-Exceed Speed is somewhat less than V_{NE} so we know that we can still apply some small aileron deflection at that speed.

We all know about that critical consideration of rolling G. Again, it follows from a design requirement in FAR 23 and it is also explained in the Decathlon Flight Manual. CASA's CAAP 155-1 explains it in a bit more detail and suggests that it is a rule of thumb – nope, it is written into the law that designers must certify their aeroplanes to – 2/3 of the positive maneuvering load factor. So, for a typical aerobatic aeroplane with a 6G limit load factor, the rolling G limit is 4.

There is an interesting statement in CAAP 155-1: “Thus, to stay within a safe operating envelope, the pilot should manoeuvre near V_A with caution, monitor the accelerometer rather than rely solely on airspeed limitations, respect rolling G and flick roll limits, and be cautious in the use of abrupt control inputs.” Note that neither the full definition of Maneuvering Speed provided in Part 2 nor FAR 23 prohibits sudden control deflection anywhere in the flight envelope. i.e. you can hit it hard but be very aware of how far you may move it, and the possible need to back it off quickly.

The current version of FAR 23 requires the structure of aerobatic aeroplanes to be specifically designed for snap maneuvers however many aerobatic aeroplanes were certified prior to this 1996 requirement, or perhaps even certified prior to FAR 23. Some limited flight testing would have been done on loads during snap rolls to determine the recommended entry speeds and would’ve considered the following rationale. Note the use of the word “recommended” which is what you will see in most Flight Manuals regarding flick roll entry speed. i.e. despite that statement in the CAAP it is very rare to have snap roll limits but it is wise to regard the maximum recommended speed for snaps as a limit – loads increase quite significantly at higher speeds and will damage the aeroplane.

Time to look at that nominal flight envelope again. If we have an aeroplane with a maximum G of 6 then the rolling G is 4. Follow the 4g line horizontally to the accelerated stall line and then straight down to see that the indicated airspeed is double the stall speed.



Consider what we may do with the controls if the airspeed is no more than double the stall speed. Nothing we do will result in us exceeding 4G so we can apply full elevator and full aileron simultaneously. This speed is of more practical use than Maneuvering Speed and is, in fact, what many people have been using for the definition of Maneuvering Speed – recall one of the explanations from Part 1:

“The maximum speed at which the limit load can be imposed (either by gusts or full deflection of the control surfaces) without causing structural damage.”

Now we know that this definition doesn't apply to Maneuvering Speed but (for a 6G aeroplane) to twice the stall speed OR, more generally (and after some simple mathematics), about 80% of Maneuvering Speed. I like to call this the Multi-Maneuvering Speed – we may apply multiple control deflections below this speed without damage to the airframe. This is the origin of one rule of thumb that you may encounter for the maximum snap roll speed for an aeroplane (if there is nil information in the Flight Manual).

I thought that I should give you some homework prior to Part 4. Are we allowed to apply full forward stick at Maneuvering Speed?

Also in Part 4 we will look at an actual flight envelope.