The Risks of Maneuvering Speed Myths – Part 3

At the end of Part 3 published in the August 2015 edition of Vitamin G, the official magazine of the Australian Aerobatic Club, I gave readers some homework:

"Are we allowed to apply full forward stick at Maneuvering Speed?"

I also promised to look at an actual flight envelope. In earlier parts of this article I had simply provided a sample flight envelope from the USA FAA's Handbook of Aeronautical Knowledge. Aircraft manufacturer's seem shy about publishing such detail in their manuals so rely on a good general knowledge of flight envelope construction per the airworthiness regulations. For example, a manual may state the aerobatic limit load factors as +6/-3 G so you might reasonably expect those limits to apply generally. The observant readers would've noticed that in my sample flight envelopes the negative G limit is truncated above V_{NO}. That is a general characteristic of FAR 23 flight envelopes. At V_{NE} the negative limit load factor for an aerobatic aircraft is only about -1.0!

Let's have a look at the Flight Envelope for the most prolific aerobatic aeroplane in the world, the Pitts S-1S. The Owner's and Maintenance Manual states:

"The airframe of the Model S-1S has been verified for loads in excess of the Federal Aviation Agency Requirements for the stringent Aerobatic Category, at 1150 lb. gross weight. This means, in practical language, that at indicated airspeeds of 154 mph or less, you may apply sudden full aileron, rudder, or nose-up elevator deflection without exceeding the airframe minimum design loads. Sudden full nose-down elevator may likewise be applied at 106 mph indicated or less, without exceeding the design loads."

Well, that should answer your homework question!

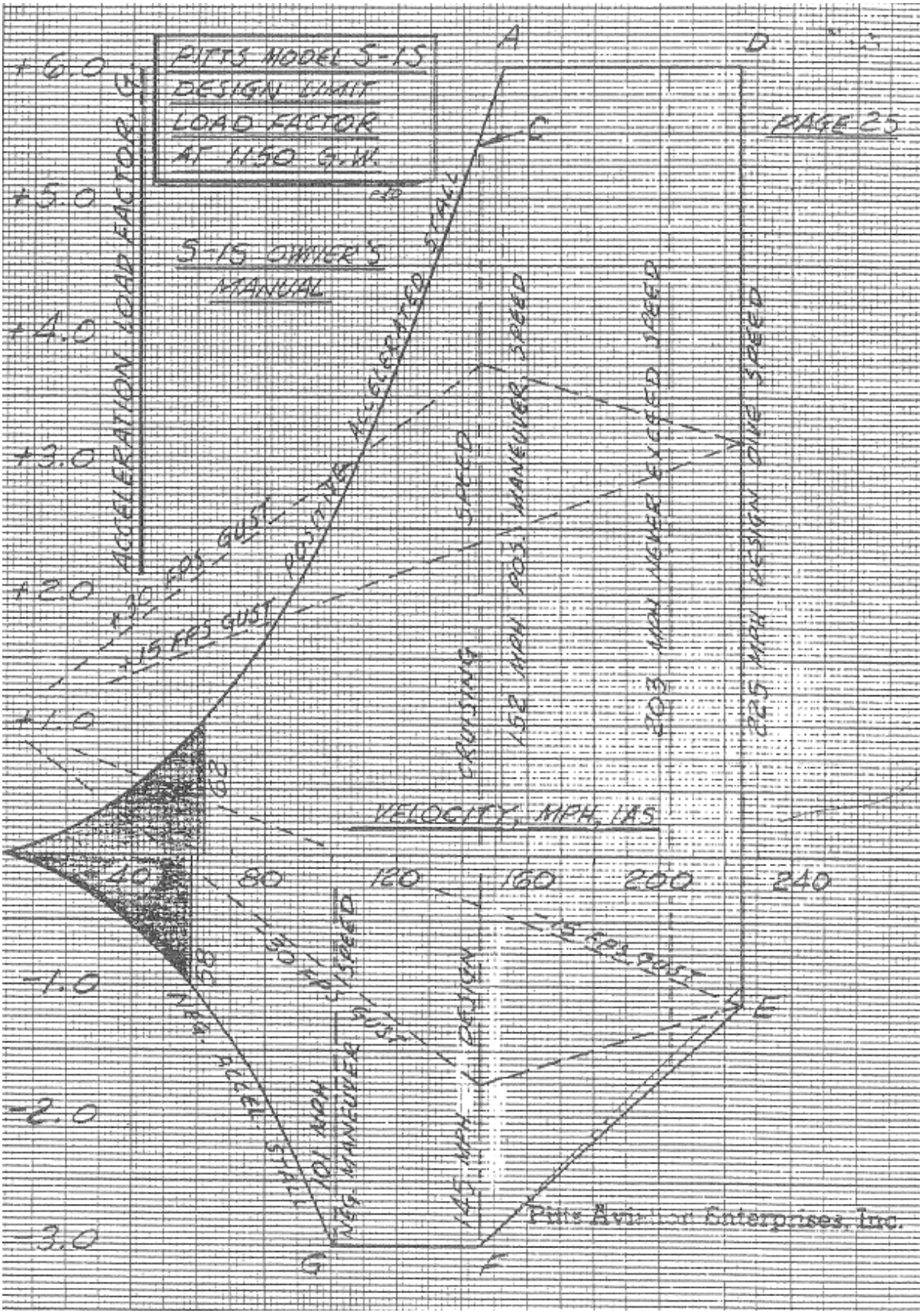
"These relationships are shown graphically on the V-G diagram of page 25."

So, Pitts pilots have access to the full design envelope.

"If you compare the recommended entry speeds for various demonstrated maneuvers, shown on next page, with the V-G diagram, it should be clear that if you feel you need more airspeed than the tabulated values show, you are not properly performing the maneuver, and you may be overloading the airframe. Do not exceed the limitations shown on the V-G diagram; every maneuver in the Aresti ladder can be performed from combinations of the ones shown here."

From the V-G diagram shown below you can see that above 145 mph (126 kts) the negative limit load factor progressively reduces from -3 to -1.15 at V_{NE}.

Another interesting feature is that the Design Cruising Speed (maximum structural cruising speed or maximum speed for normal operations) V_{NO} of 145 mph (126 kts) is less than the Maneuver Speed V_A of 152 mph (132 kts). Normally V_{NO} is greater than V_A but with a high drag (or low power) aircraft this is often the case but sometimes the designer elects to reduce V_A so that it equals V_{NO} which means that V_A is no longer that corner of the Flight Envelope. In the case of the Pitts S-2A the designer instead decided to increase V_{NO} so that it equals V_A.



As you can see the V-G diagram also shows the design gust loadings which are generally not significant for an aerobatic aeroplane.

If you fly an aeroplane which is not certified aerobatic per FAR 23 then you have other considerations:

- Aerobatic does not necessarily mean that it is +6/-3 – the figures may be much lower. +4.5 G was a common limit for semi-aerobatic category in Australia, NZ and the UK. 5 G was often used for American aerobatic aeroplanes long before FAR 23.
- The positive limit load factor may also decrease at speeds above V_{NO}

Of course, FAR 23 represents the minimum so the designer is always free to choose higher design limit load factors than +6 and -3. As for uncertified aircraft:

- Home-builts? A home-built Pitts S-1E may be identical to a factory S-1S or something entirely different.
- Limited category aircraft are generally not certified to any recognised civil airworthiness standards so may have their own surprises.