Safety Bulletin

Topic: Flutter is Real

Very few pilots will have experienced flutter. It can present as a small vibration associated with, for example, a trim tab as it reacts with a control surface. Or it can present as violent shaking of the airframe which can destroy an aircraft in a very short time, potentially in a fraction of a second. This is one reason why VNE is so important.

You must know what your aircraft's VNE is, and whether it is defined by the aircraft manufacturer or designer as Calibrated Air speed (CAS) or True Air Speed (TAS). If you are not sure of the definition – play it safe – assume it is TAS.

1. INTRODUCTION

The New Zealand CAA have recently released their investigation report of the in-flight breakup of a Vans RV7 aircraft.

This accident occurred on New Year's Day 2018, in Northland New Zealand, killing both occupants. The report found that in-flight breakup occurred as a result of "rudder flutter", as the aircraft airspeed exceeded the design limitations. The rudder flutter resulted in the separation of both the rudder and the vertical stabiliser.

This accident has caught the attention of the RV community because of the structural failure, similar it would seem to two previous RV accidents, one in Canada and the other in Arizona USA.

2. DISCUSSION

For a high inertia/low drag aircraft, the RV7 has a relatively low Manoeuvre speed (123kts) and a caution arc that starts at 167kts. These speeds really need to be understood, particularly when conducting aerobatics or unusual attitudes.

While this accident involved a Vans RV7, it is not just about these types. In our Experimental Amateur Built class, we have a very high percentage of aircraft types that can be categorised as high inertia/low drag aircraft.

The installation of larger engines and higher horsepower can enable regular operation close to the edge or outside the performance envelope. We need to be aware of our flight envelope and speed limitations, they are real, so be very careful while manoeuvring and do slowdown in turbulence.

Some kind of Upset Training may save the day. Flutter is real and may be hard to detect as you approach VNE. Know exactly what you need to do if you do find yourself in an unusual attitude, these actions are memory or recall and should be known.

Stay current through Type Transition Training / Recurrent Training with someone who knows your aircraft well. Talk to an SAAA Flight Safety Advisor (FSA) or other experienced pilot.

If your aeroplane is fitted with an EFIS system, we highly recommend audible warnings along with the visual warning. You can custom program your EFIS to tell you that you are at a limit speed for example.

Often (but not always) an experimental amateur built aircraft performance envelope is defined by velocity vs load factor (G), i.e. the Vn diagram; and FAA GA aircraft design categories e.g. acrobatic, utility, normal.

The RV-7 design uses the acrobatic category specifications: designed for +6 and -3 symmetrical G (acceleration) at 1600lb (725kg) gross weight. Between 1600 and 1800lb (816kg) maximum design gross weight of the RV-7, the reduced utility category specification limits of between +4.4 and -1.75 symmetrical G may apply.

The RV-7 asymmetrical (‘rolling G’) limits are not defined for the RV-7, but the following design specification limits should be observed:

- at or below 1600lb (725kg) - between +4 and -2 rolling G.
- from 1601lb to 1800lb (816kg) - between +2.9 and -1 rolling G.

Please note that as G increases, the aircraft structure accumulates fatigue stress at an exponential rate proportional to G.

RV-7 design speeds are in mph. Converted to knots they are as follows:

- VNE (Never Exceed Speed) is 200 **KTAS** (i.e. TAS not IAS: Red Line; top of Yellow Arc), usually determined by flutter.
- VNO (Maximum Structural Cruising Speed) is 167 KIAS (bottom of Yellow Arc, top of Green Arc) usually defined by g limits and specified vertical gusts.
- VNO is easily exceeded at moderate power and moderate rates of descent in high inertia/low drag aircraft.
- Va (Manoeuvring Speed, about 123 KIAS, Blue line) is defined by clean stall speed and the square root of the G limit for all up weight (AUW):
    - 1800lb (816Kg) – 57 x √4.4G = 119KIAS
    - 1600lb (725Kg) – 51 x √6.0G = 125KIAS

Please note the following:

- Many experimental aircraft, including RVs, are capable of exceeding VNE in level flight.
- Because VNE is a flutter limit based on True Air Speed (TAS), at higher altitudes the VNE flutter limit will be lower than VNO and thus the maximum structural cruising limit.
- Most current EFIS allow the setting of VNE as either an indicated or true air speed limit – if possible, please set VNE as a TAS limit with visual and audio warning.
- Below Va the envelope is defined by accelerated stall, but at Va or above, the pilot must limit the angle of attack (and thus pitch rate) to avoid exceeding the both the design and structural G limits.

We encourage pilots to enhance their understanding of flutter and the circumstances that can lead to this phenomenon. An excellent article was published by Australian Flying in 2010 - https://www.australianflying.com.au/news/vne-and-flutter-explained - and is well worth reading.

3. CONCLUSION

There is often much heated debate on the subject of how VNE is defined – TAS or CAS – this is the really critical bit.

This can make a huge difference, especially at higher altitudes where it could be so easy to exceed VNE in many of our aircraft that are capable of climbing into the flight levels.

An aircraft owner must go to the Pilot Operating Handbook (POH), or if required to the kit manufacturer / designer to determine if VNE is defined as TAS or CAS, and if there are any permissible changes in VNE.

So – if you do not know for sure whether the VNE quoted for your aircraft is TAS or CAS defined, play it safe – assume it is TAS! It is not negotiable.