CAA SAFETY INVESTIGATION REPORT

In-flight Breakup

Van's Aircraft Incorporated RV-7
ZK-DVS

Te Kopuru, Northland

01 January 2018

CAA final report 17/8080

27/08/2020

Contents

Executive summary

A Van's Aircraft Incorporated (Van's) RV-7, amateur built aircraft, registered ZK-DVS, was being operated on a private flight. The aircraft departed Whangarei aerodrome at 1200 hours,[1] 01 January 2018, with two people on board, the pilot, and a passenger.

At approximately 1217 hours, the aircraft entered a high angle of bank (AoB) manoeuvre, achieving 70 degrees AoB. Five seconds later the AoB increased to 130 degrees and the aircraft began to pitch nose-down. During the resulting descent, the indicated airspeed was recorded at 244 knots (kts), which exceeded the aircraft 'never exceed speed' (Vne).

Approximately 30 seconds after entering the high AoB manoeuvre, witnesses observed the aircraft break up in flight and then impact terrain approximately three nautical miles south-west of Te Kopuru.

The Rescue Coordination Centre of New Zealand notified the Civil Aviation Authority (CAA) of the accident, and the CAA commenced a safety investigation the same day.

The safety investigation identified the following contextual factors.

- The aircraft entered a high-speed descent from an unusual attitude.
- The pilot did not recover the aircraft from the unusual attitude or subsequent high-speed descent, which resulted in structural failure and in-flight breakup.
- In-flight breakup occurred as a result of rudder flutter, as the aircraft airspeed exceeded the design limitations.

Safety message

To avoid the potential of structural failure and in-flight breakup pilots must fly within the aircraft limitations.

Accidents can occur whenever the aircraft limitations and/or the pilot's own capabilities are exceeded. It is important to understand and be familiar with the aircraft characteristics, limitations, and associated risks. These risks can be minimised by preparation, awareness, and training.

[1] All times are New Zealand Standard Times (NZST)

Incident timeline

01 Jan 2018

1100 (approx.)	The pilot is observed conducting preflight checks and preparing the aircraft for the flight at Whangarei aerodrome. The pilot is accompanied by the passenger.
1200 (approx.)	ZK-DVS departs Whangarei aerodrome on a private scenic flight and tracks towards Dargaville on a westerly heading, at approximately 2,100 feet (ft).
1212 (approx.)	Overhead Dargaville the aircraft turns on to a south-easterly heading and climbs to an altitude of approximately 4,500ft.
1215 (approx.)	The aircraft conducts a series of medium turns (approximately 30° AoB) placing the aircraft on an approximate southerly heading.
1216:33	The Electronic Flight Information System (EFIS) records the aircraft in a steep left bank manoeuvre with an AoB of 70°. The aircraft pitch is approximately 09° nose-down. The indicated airspeed (IAS) is recorded at 148kts. During this manoeuvre, the aircraft descends approximately 270ft, before rolling wings-level and then climbing back to an altitude of approximately 4,500ft.
1217:03	The EFIS records the aircraft in a steep right-bank manoeuvre with an AoB of 70°. The aircraft pitch is approximately 20° nose-up. IAS is recorded at 132kts. The manifold pressure is recorded at 24.3in/hg.[2]
1217:08	The next record reports that the right bank has increased to an AoB of 130°. The aircraft pitch has reduced to approximately 20° nose-down. IAS is recorded at 130kts. The aircraft is now on a south-westerly heading. Manifold pressure is recorded at 24.2in/hg.
1217:13	Pitch reduces to approximately 60° nose-down. The AoB has reduced to 57° to the right. IAS is recorded at 183kts. The aircraft has descended to an altitude of 3,770ft. The aircraft is now on a north-westerly heading. Manifold pressure is recorded at 25.3in/hg
1217:19	Aircraft pitch is approximately 30° nose-down, wings almost level. The IAS is recorded at 244kts. The altitude at this time is recorded at 2,310ft. The aircraft is now on a northerly heading. Manifold pressure is recorded at 20.8in/hg.
1217:23	The aircraft has now rolled to the left, with an approximate 40° AoB recorded. Pitch remains 30° nose-down. IAS is recorded at 99kts.

[2] Manifold pressure is a measure of pressure in the engine induction manifold relevant to throttle position. High manifold pressure indicates throttle open, and a low manifold pressure indicates throttle closed.

	Altitude is recorded at 1,560ft. The aircraft remains on a northerly heading. Manifold pressure is now 14in/hg.
1217:30 (approx.)	Witnesses observe the aircraft impact terrain and alert emergency services.

Incident diagram and wreckage pictures

Figure 1: Wreckage distribution and aircraft position reports from EFIS

Figure 2: Main wreckage (Source: scene investigation – note: strop around wing used for aircraft wreckage recovery)

Figure 3: Right wing (Source: scene investigation)

Findings and conclusions from the investigation

The investigation covered human factors, equipment factors, and environmental factors. The key findings are listed below and are then described in more detail.

Human factors

- The aircraft entered a high-speed descent from an unusual attitude, either because:
    - The pilot conducted a steep AoB or aerobatic type manoeuvre, or
    - The pilot lost visual reference due to inadvertent flight into Instrument Meteorological Conditions (IMC), or
    - It could not be conclusively discounted that the passenger was controlling the aircraft at the time.
- The pilot did not recover the aircraft from the unusual attitude or subsequent high-speed descent, most likely because:
    - The pilot found himself in a situation he was not prepared for nor expected.
    - Negative transfer may have influenced the pilot's action.
    - The effects of startle may have also contributed to a delay in recovery actions.

Equipment factors

- In-flight breakup occurred as a result of rudder flutter, as the aircraft airspeed exceeded the design limitations.
    - No pre-accident defects were found with the aircraft.
    - Wreckage signatures were consistent with rudder flutter.
    - The aircraft reached an airspeed in excess of the design limitations.
    - EFIS alert functions can be optimised to aid pilots effectively manage a potential hazard.

Environmental factors

- Weather was considered not to be a contributing factor but played a contextual role.

Human factors

The aircraft entered a high-speed descent from an unusual attitude

The reason the aircraft entered an unusual attitude could not be conclusively determined, however it is possible that it may have been either because:

The pilot conducted a steep AoB or aerobatic type manoeuvre

The pilot was appropriately rated and current on the aircraft, having conducted approximately 105 hours on type and approximately 20 hours in the last 90 days.

The pilot conducted his last Biennial Flight Review (BFR) on 06 October 2017 and nil comments or issues were noted on the BFR form. An interview was conducted with the instructor who carried out the pilot's BFR and the instructor stated that he identified no issues with the way the pilot flew. The BFR was conducted in ZK-DVS. Both medium and steep turn manoeuvres were conducted, and the pilot was assessed competent in both.

The CAA provides a Flight Instructors Guide as an online resource for instructors and students. According to the CAA Flight Instructor Guide a steep turn involving an AoB of about 60° is generally approved as a semi-aerobatic manoeuvre in most light training aeroplane's flight manuals. The pilot did not hold an aerobatic rating and witness statements indicated that the pilot did not like to conduct aerobatics. Witnesses also stated that he was generally a "straight and level" pilot and would "climb to seek smoother air".

Prior to take-off the pilot entered weight and balance data into the aircraft EFIS, which indicated that the aircraft all-up weight was within normal category weight, but above the maximum allowable for aerobatic manoeuvres.

Analysis of the flight data recovered from the aircraft provided evidence that the pilot had begun to perform manoeuvres involving increasingly steeper AoB during previous flights leading up to the accident flight. On the accident flight, leading up to the accident sequence, the pilot conducted two steep 70° AoB manoeuvres.

The pilot lost visual reference due to inadvertent flight into Instrument Meteorological Conditions (IMC)

The flight was being conducted under Visual Flight Rules (VFR). Civil Aviation Rule (CAR) 91.301 *VFR meteorological minima* describes the minimum flight visibility and distance from cloud that a pilot-in-command operating under VFR must comply with.

In accordance with CAR 91.301, when operating at or below 3000ft above mean sea level (AMSL) or 1000ft above the terrain, whichever is higher, a pilot must be clear of cloud, in sight of the surface and have a minimum visibility of 5km. When operating above 3000ft AMSL or 1000ft above terrain, whichever is higher, a pilot must be no less than 2km horizontally and 1000ft vertically from cloud. The minimum flight visibility below 10,000ft AMSL is 5km.

Anecdotal evidence from individuals who knew the pilot, indicated that the pilot liked to fly "around the clouds". On the day before the accident flight, the pilot had conducted a local flight in ZK-DVS, to the north-west of Whangarei. During this flight, the pilot climbed the aircraft to an altitude of approximately 6,000ft. On the accident flight the pilot climbed the aircraft to an altitude of approximately 4,500ft. On both days cloud layers were reported to be either at or below these altitudes (refer environmental factors section).

In addition to holding a private pilot licence - Aeroplane (PPL-A), the pilot also held an airline transport pilot licence - Helicopter (ATPL - H), with an instrument rating. Thus, the pilot would have received training and operational experience in IMC during his piloting career.

Although the pilot held an instrument rating, research has shown that the effects of spatial disorientation associated with an inadvertent IMC encounter, can still impact the performance of instrument rated pilots.[3]

The safety investigation could not conclusively determine if the aircraft inadvertently entered cloud. If, however, an inadvertent IMC encounter did occur, it is possible the pilot experienced the effects of spatial disorientation, leading to the aircraft entering an unusual attitude.

It could not be conclusively discounted that the passenger was controlling the aircraft at the time

According to CAA records the passenger had held a Class 1 medical certificate, which expired in June 2012, and a Class 2 medical certificate that expired in June 2016. There were no records of the passenger ever attaining any type of pilot licence.

It could not be determined from the physical evidence, who was in control of the aircraft when the in-flight breakup occurred. However, witness statements indicated it was not general practice for the pilot to relinquish control of the aircraft to passengers during flights.

Although the safety investigation considers it unlikely that the passenger was at the controls at the time, there have been other aircraft accidents which provide examples of this occurring. A recent example is the fatal accident involving a RANS Aircraft s-19,[4] the safety investigation raised the Safety Message: There are risks associated with allowing someone who is not appropriately qualified to manipulate the controls of an aircraft.

A person who is not appropriately qualified to take the controls of an aircraft, may only do so in the presence of a qualified flying instructor. This is because instructors, unlike the general pilot population, are trained to recognise when things are going wrong, and to take the appropriate remedial action in a timely manner.

[3] Crognale, M. A. & Krebs, W. H. (2008). Helicopter Pilot Performance: Inadvertent Flight into Instrument Meteorological Conditions. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 52*(18), 1190-1193

[4] https://www.aviation.govt.nz/assets/publications/fatal-accident-reports/zk-mbx-fatal.pdf

The pilot did not recover the aircraft from the unusual attitude or subsequent high-speed descent

The pilot found himself in a situation he was not prepared for, nor expected

Although the pilot had conducted both medium and steep turn manoeuvres during his last BFR on 06 October 2017, the last time the pilot's logbook recorded steep turns involving an AoB of about 60° (max rate turns) was 30 July 2002. (Refer Appendix 1: Pilot experience information).

One of the considerations described in the CAA Flight Instructors Guide for steep turns is that of the spiral dive, which states:

> *'If the angle of bank is permitted to increase, insufficient vertical component of lift will be produced, and the aeroplane will descend. The natural tendency is to attempt to pitch the nose up by increasing backpressure. Because of the high angle of bank, this tightens the turn and increases the rate of descent.'*

In 2015 the Federal Aviation Administration issued Advisory Circular (AC) 90-109A - Transition to Unfamiliar Aircraft. The purpose of the AC is to provide information and guidance to pilots who fly or intend to fly experimental, simple, complex, high-performance, and/or unfamiliar aircraft on the performance and handling characteristics of these aircraft.

The AC states that a major objective in aircraft design is the reduction of drag. High inertia / low drag aircraft are on the leading edge of this design trait, being fast, efficient, and having significant range. According to Appendix 2 of the AC the Van's RV-7 is categorised as a high inertia / low drag aircraft. A hazard associated with this type of aircraft as stated in Appendix 4 of the AC is that unless managed these aircraft can build excessive speed particularly in descent phases, which may lead to loss of control.

Thus, if during a high AoB manoeuvre the aircraft nose pitch is permitted to drop and the aircraft allowed to descend without a reduction in power, the airspeed of a high inertia / low drag aircraft can rapidly increase. This can result in the exceedance of the aircraft structural design limits.

From the evidence available to the safety investigation, the pilot had not conducted steep turns involving an AoB of about 60° in ZK-DVS before the accident flight. It is considered possible that the pilot may have been unfamiliar with the performance and handling characteristics of the aircraft and risks associated with flying the aircraft with high angles of bank.

Negative transfer may have influenced the pilot's action

Negative transfer can be considered to be where skills acquired in one setting, such as helicopter training, can inhibit or impair performance in another setting, such as fixed-wing aircraft operations.

At the time of the accident the pilot had accrued approximately 380 hours fixed-wing experience and approximately 4300 hours helicopter experience. The pilot was employed as a helicopter pilot at the time of the accident and his most recent helicopter flying had been conducted in a Sikorsky S-76C.

As part of the pilot's previous training he would have conducted unusual attitude training. His most recent unusual attitude training would have been the unusual attitude recovery procedure for the Sikorsky S-76C taught during the initial conversion course.

The procedure for recovery from unusual attitudes differs between fixed-wing aircraft and helicopters. Recovery from a nose-low unusual attitude, taught as part of a fixed-wing pilot licence is as follows:

1. Reduce power; and simultaneously level the wings.
2. Ease out of the dive, and check airspeed.

The recovery from unusual attitudes taught to pilots on the initial conversion course for the Sikorsky S-76C is as follows:

1. Level the wings;
2. Place the nose of the aircraft on or slightly above the horizon; and
3. Apply power to arrest the descent/climb to a safe altitude.

The sequence of actions taught to pilots as part of the recovery from unusual attitudes procedure in the helicopter type that the pilot was familiar with, does not call attention to power until after the aircraft attitude is attended. This differs to the fixed-wing procedure, which requires the reduction of power to be carried out while simultaneously levelling the wings.

From the evidence available to the safety investigation, it would appear that the pilot did not reduce the power expeditiously, which led to the high-speed descent.

The effects of startle may have also contributed to a delay in recovery actions

Startle can be defined as a brief, rapid, and highly physiological reaction to a sudden, intense, or life-threatening stimulus. Human factors research into fear potentiated startle,[5] describes startle as having effectively three concurrent processes, the physical reflex actions, including aligning attention toward the unexpected stimulus; the flight or fight response; and a slower but longer lasting activation of the stress response.

[5] Martin, W. L., Murray, P. S., Bates, P. R., & Lee, P. S. Y. (2015). Fear Potentiated Startle: A Review from an Aviation Perspective. *The International Journal of Aviation Psychology, 25*(2), 97-107.

Further research has shown that moderate startle, independent of stress effects such as narrowed attention, degraded problem solving, etc., can cause degraded information processing for up to 30 seconds.[6,7]

The safety investigation concluded that the combination of the effects of both startle and negative transfer may have led to a delay in the reduction of power, when the aircraft was in a situation where the airspeed could rapidly exceed the aircraft design limitations.

Equipment factors

In-flight breakup occurred as a result of rudder flutter, as the aircraft airspeed exceeded the design limitations

No pre-accident defects were found with the aircraft

The Van's Aircraft Incorporated RV-7/7A are amateur built single-engine aircraft built from a kitset. The aircraft are of all metal construction, low-wing, side-by-side seating configuration. The RV-7 is a tail-wheel variant and the RV-7A is of a tricycle-gear configuration. ZK-DVS was an RV-7, tail-wheel configuration, and was fitted with an EFIS. The aircraft was built from a kitset by the pilot and his partner.

The aircraft was registered as ZK-DVS in September 2015 and issued an airworthiness certificate in the special category - experimental by the CAA in June 2016 pending a 40 hour flight evaluation. Flight testing was completed 12 October 2016, accumulating 44.7 hours flight time and the aircraft was subsequently issued an airworthiness certificate in the special category – amateur built, by the CAA in October 2016.

The last inspection carried out on the aircraft was a 100hr/annual inspection on 13 June 2017. All applicable airworthiness directives and Van's Aircraft repetitive service bulletins had been complied with. The safety investigation found no faults, defects or concerns with the aircraft or its construction.

Wreckage signatures were consistent with rudder flutter

The main wreckage site contained the engine, propeller, and the aircraft fuselage. Attached to the aircraft fuselage were the left wing, the horizontal stabiliser, and the lower rudder attachment frame, attached only by the rudder control cables (Figure 2). The vertical stabiliser and top half of the rudder were located approximately 600 metres south-east of the main wreckage site. The right wing was located approximately 450 metres south-east of the main wreckage site (Figure 1).

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[6] Thackray, R. I., & Touchstone, R. M. (1970). Recovery of motor performance following startle. *Perceptual and motor skills, 30*(1), 279-292.

[7] Woodhead, M. M. (1959). Effects of brief loud noise on decision making. *The Journal of the Acoustical Society of America*, 31(1), 1329-1331.

The top half of the rudder was still attached to the vertical stabiliser at the top and centre hinges and had fractured in half just below the centre hinge. The rudder had split open at the trailing edge riveted joint. The skin fracture surfaces were consistent with overstress. There were no indications of progressive failure. Numerous parts of the rudder, including the rudder balance weight and lower skin section, had separated from the main rudder structure (Figure 4).

Research of accidents involving Van's RV-7 aircraft identified two accidents in which the wreckage signatures were similar to that of ZK-DVS. One accident occurred in the United States of America involving Van's RV-7A, registered N174BK (Figure 5). The other accident occurred in Canada involving Van's RV-7A, registered C-GNDY (Figure 6) (refer Appendix 2: Accident reports). In both accidents, the damage to the rudder structure and the separation of the vertical stabiliser was determined to be consistent with flutter occurring in the rudder, leading to structural failure of the vertical stabiliser attachment points.

Liaison with the National Transport Safety Board (NTSB) and the Transport Safety Board of Canada (TSB) enabled detailed comparisons of the damage signatures to be made to those analysed on ZK-DVS. Similar characteristics were exhibited in all.

Figure 4: Rudder and vertical Stabiliser from ZK-DVS (Source: scene investigation – items purposely arranged after recording in-situ)

Figure 5: Rudder and vertical stabiliser from N174BK (Source: NTSB)

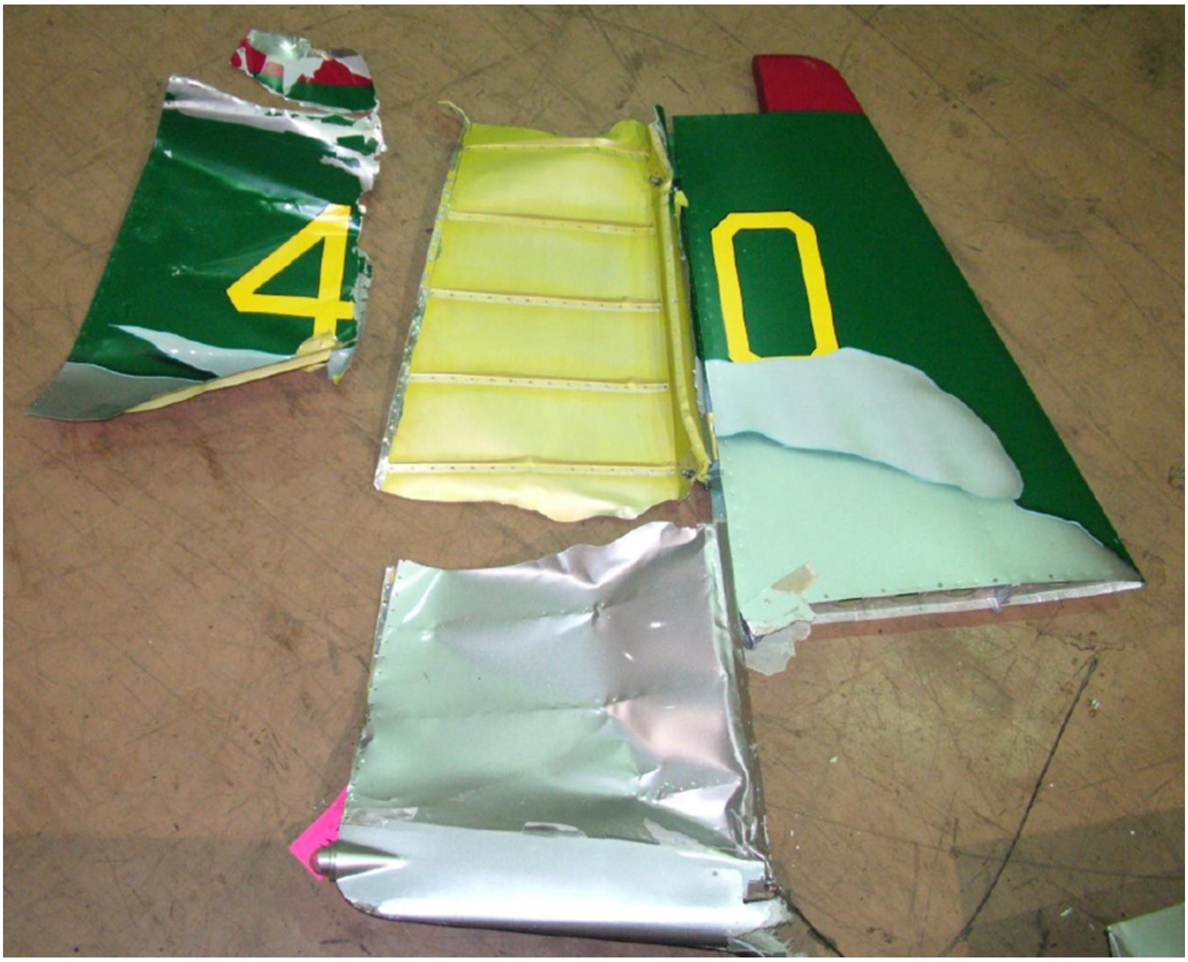

Figure 6: Rudder and vertical stabiliser from C-GNDY (Source: TSB)

Flutter can be described as a rapid and uncontrolled oscillation of a flight control surface and normally leads to catastrophic failure of the structure. The factors that can contribute to the onset of flutter include high airspeed, a reduction in structural stiffness and a change in mass distribution. Due to the high frequency of oscillation, even when flutter is on the verge of becoming catastrophic, it can still be very hard to detect. The safety investigation considered it likely that the vertical stabiliser and rudder separated in flight due to the significant forces associated with flutter.

The aircraft reached an airspeed in excess of the design limitations

The aircraft 'never exceed speed' (Vne) stipulated in the Pilot Operating Handbook (POH) for Van's RV-7 ZK-DVS is 200kts. Analysis of the flight data recovered from the EFIS installed in ZK-DVS determined that the maximum airspeed recorded during the accident sequence was 244kts, 44kts above Vne. Given that the flight data was recorded at five-second intervals, it is possible that in the seconds preceding or succeeding this recording, the actual airspeed could have exceeded 244kts.

Van's Aircraft has conducted stick raps and rudder pedal kicks testing to 220kts,[8] with no indication of flutter up to this airspeed. Flight at any airspeed over Vne, however, exposes the aircraft to the possibility of flutter.

Van's RV-7 aircraft are designed to be operated in both aerobatic and normal categories. The POH for ZK-DVS stipulates that for operations under the normal category the aircraft maximum weight is 1900lbs and for operations under the aerobatic category the aircraft maximum weight is 1550lbs. The POH also includes the following caution: "The maximum weight recommended by Van's Aircraft is 1800lbs. Operations at 1900lbs must be conducted with caution". Under the normal category, at a maximum weight of 1800lbs, Van's Aircraft state that the 'g' limits are +4.4 and -1.75. At the time of the accident the aircraft was calculated to weigh approximately 1800lbs.

Under normal operation, flying the aircraft within its flight envelope, the loads acting upon the aircraft should stay within the limits. Flying with excessive airspeed can result in loads on the aircraft in excess of design limitations.

The safety investigation considered it probable that the failure of the horizontal stabiliser was due to a combination of: The effects of flutter, the damage to the aircraft associated with the departure of the vertical stabiliser and rudder, and the aerodynamic forces associated with flight at excessive airspeed.

As stated in the NTSB aviation accident report, involving a Van's RV-7, N307AB "Failure of the horizontal tail first would cause the airplane to pitch down rapidly, producing air loads on the upper surface of the wing that were sufficient to fail them in negative overload"

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[8] Stick raps and rudder kicks are traditional flight test techniques to collect aircraft flutter data. The technique involves a sudden control impulse (for example striking the stick with the palm of the hand) to produce a sudden control surface movement.

(refer Appendix 2: Accident reports). The damage to the right wing of ZK-DVS was consistent with a downward failure in negative overload (Figure 3).

EFIS alert functions can be optimised to aid pilots effectively manage a potential hazard

EFIS are electronic displays, which integrate and depict all of the information conventional electromechanical flight instruments present to the pilot. EFIS generally comprise of a primary flight display (PFD) or multifunction display (MFD). A PFD displays information required by the pilot to determine basic flight parameters, such as altitude, attitude, airspeed and heading, etc. MFDs provide further information such as engine monitoring and navigation displays.

Most EFIS have the ability to alert or warn the pilot if a parameter, such as airspeed reaches pre-set limits. The type of warning however can differ across EFIS makes and models. Some provide visual cues; some also provide an audible tone, while others provide a verbal warning. The EFIS installed in ZK-DVS provided the pilot with a visual warning if Vne was exceeded. This visual warning consists of a barber pole style hash, which will automatically display above Vne. The EFIS, however does not have an audible warning associated with an exceedance of Vne.

Research conducted by the San Jose State University, states that the purpose of an alert or warning in a complex, safety-critical system, such as aviation, is to initiate the appropriate response for managing a hazard.[9] The study specifies that an alert or warning should help the pilot:

- Orient – draw the pilot's attention
- Understand – inform the pilot of the nature and urgency
- Identify appropriate actions – provide a link to action
- Identify the priority – inform the pilot of the action of highest urgency
- Execute the actions – support the pilot in executing the actions and providing feedback that the unsafe state has been resolved.

Human factors research indicates that auditory signals can be preferable to visual means, even when vision is not overburdened. Furthermore, verbal or voice warnings are potentially more informative than simple tone warnings. This is because they not only alert the pilot to the unsafe state, but simultaneously provide more cues as to the nature of the hazard and therefore assist the pilot in taking the immediate actions needed.

Although the safety investigation concludes that the type of warning (visual vs audible) did not cause the accident, the safety investigation raised this safety observation with the EFIS manufacturer. In the interest of improving safety and to better enable pilots to effectively manage a potential hazard the EFIS manufacturer agreed to give this safety observation due consideration.

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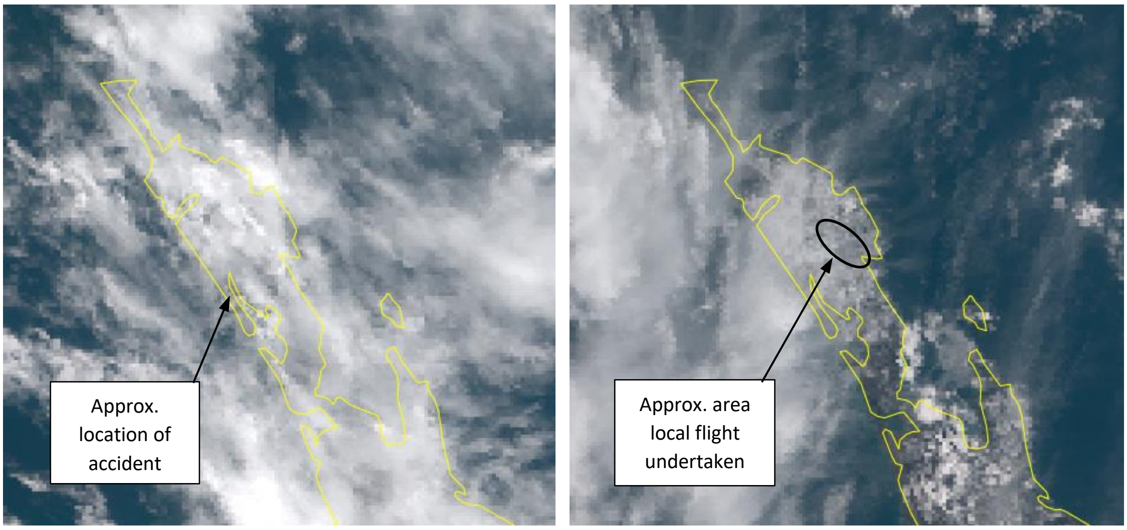
[9] Mumaw, R. J. (2017). Analysis of alerting system failures in commercial aviation accidents. *Proceedings of the Human Factors and Ergonomics Society 2017 Annual Meeting, 16*(1), 110-114.

Environmental factors

Weather was considered not to be a contributing factor but played a contextual role

At the time of the accident flight, the cloud base for the region in which the flight was being conducted was forecast to be approximately 4,100ft. The cloud base for the region during the time of the local flight conducted to the north-east of Whangarei on the day before the accident flight, was reported to be around 3500ft – 4500ft, with an additional layer of cloud beginning to form at 6,000ft. Figure 5 shows the satellite imagery of the region at the approximate time and date of the accident flight and the local flight carried out the day before.

The safety investigation has found no evidence to indicate the weather conditions contributed to this accident. It can be observed, however, that the aircraft had been flown at altitudes at which cloud layers had been forecasted and reported to have formed.



1200 Day of the accident 1100 day before

Figure 7 - Satellite imagery showing cloud cover in the region (Source: Japan Meteorological Agency Himawari-8 satellite imagery, supplied by MetService NZ)

Safety actions

Actions already taken

VAN'S safe operation: airmanship and developing a culture of safety

The Van's Aircraft Inc. website provides a significant amount of safety information relating to the design, build and operation of the RV series aircraft. This information can be found through the following link: https://www.vansaircraft.com/safety/

Vector article – Outside the limits

A *Vector* magazine article – "Outside the limits" was published in the spring 2019 issue. The article aims to raise awareness of the risks associated with flying an aircraft close to or beyond the aircraft limitations. https://www.aviation.govt.nz/safety/publications/vector-articles/show/outside-the-limits

Verbal commands for Electronic Flight Information System

In April/May 2020 the manufacturer of the EFIS installed in ZK-DVS incorporated a 'spoken' audio alert into their latest EFIS screens. The pilots' guide covering version 16 of the software includes the following description: *'The EFIS will generate a spoken audio alert "Overspeed" if the aircraft exceeds the Vne value'.*

Further actions we recommend

Sport Aircraft Association of New Zealand (SAANZ) recommendation

To help pilots of high inertia / low drag aircraft such as the RV-7, gain the knowledge and skills required to fly safely, a recommendation was raised with the SAANZ to build awareness of the following aspects, during initial and ongoing training, as well as through their safety promotional material:

- The performance and handling characteristics associated with high inertia / low drag aircraft.
- The risk associated with operating close to the aircraft flight envelope and/or design limitations.
- The potential human factors that may influence the pilot's ability to recover from an unsafe state.

Experimental Aircraft Association (EAA) recommendation

In the interest of further improving safety, and better enabling pilots of light sport aircraft with different types of EFIS installed, a recommendation was raised with the EAA to facilitate further discussion with EFIS manufacturers in general, with an aim to:

- Raise awareness of the human factors aspects of audible vs visual alerts/warnings, and,
- Give due consideration to integrating audible warnings, appropriate to the recovery actions required, in the event of hazardous aircraft states, to better enable pilots to effectively manage the hazard.

Other safety messages from this investigation

Vector Article – Stay in Control

A *Vector* magazine article – "Stay in Control" was published in the July/August 2018 issue. The article aims to raise awareness of the risks associated with allowing someone who is not appropriately qualified to manipulate the controls of an aircraft.
https://www.caa.govt.nz/assets/publications/vector/Vector-2018-4.pdf

Accident data summary

Aircraft make and model, registration:	Van's Aircraft Incorporated RV-7, ZK-DVS
Serial number:	73295
Engine make and model, type of engine:	Lycoming IO-360-A1B6, 200 HP
Year of manufacture:	2016
Accident date and time:	01 January 2018, approximately 1217 NZST
Location:	Approximately 3NM, SW of Te Kopuru. Latitude S36°4'7.00" Longitude E173°57'16.10"
Type of flight:	Private
Injuries:	Two fatal
Nature of damage:	Destroyed
Pilot's licences:	Private pilot licence - Aeroplane, Airline transport pilot licence - Helicopter
Pilot's age:	53 years
Pilot's total flying experience:	381.2 hours (fixed-wing) 4335.9 hours (helicopter)
Information sources:	Civil Aviation Authority field investigation
Investigator in charge	Mr M Harris

About the CAA

New Zealand's legislative mandate to investigate an accident or incident is prescribed in the Transport Accident Investigation Commission Act 1990 (the TAIC Act) and Civil Aviation Act 1990 (the CA Act).

Following notification of an accident or incident, TAIC may open an inquiry. CAA may also investigate, subject to Section 72B(2)(d) of the CA Act which prescribes the following:

> **72B Functions of Authority**
>
> (2) The Authority has the following functions:
>
> > (d) To investigate and review civil aviation accidents and incidents in its capacity as the responsible safety and security authority, subject to the limitations set out in Section 14(3) of the Transport Accident Investigation Commission Act 1990

The purpose of a CAA safety investigation is to determine the circumstances and identify contributory factors of an accident or incident with the purpose of minimising or reducing the risk to an acceptable level, of a similar occurrence. The safety investigation does not seek to ascribe responsibility to any person but to establish the contributory factors of the accident or incident based on the balance of probability.

A CAA safety investigation seeks to provide the Director of Civil Aviation with the information required to assess which, if any, risk-based regulatory intervention tools may be required to attain CAA safety objectives.

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Appendix 1: Pilot experience information

Pilot's fixed-wing training and flight experience timeline

May	1998	The pilot starts flight training in a Beech 77.
Jan	1999	The pilot passes his PPL-A flight test, conducted in a Beech 77.
Feb	1999	The pilot conducts a Beech 23 type rating.
Mar	1999	The pilot completes his PPL-A cross-country flight training, conducted in a Beech 23.
Oct	1999	The pilot conducts a Cessna 150D type rating.
Sep	2000	The pilot conducts a Cessna 182R type rating.
Feb	2001	The pilot undertakes his first BFR, conducted in a Cessna 182R.
Jul	2002	The pilot's logbook records a 1.0 hour flight conducted in a Cessna 150D, which is noted to include steep (45° AoB) and max rate (60° AoB) turns. At this time, the pilot had accrued approximately 242 hours total flight time. This was the last time the pilot's logbook specifically stated the conduct of max rate turns.
Mar	2004	The pilot's logbook records 0.5 hours of flight time, noted as circuits, conducted in a C150D. At this time, the pilot had accrued approximately 272.0 hours total flight time. No further fixed-wing flight hours were recorded in the pilot's logbook until September 2015.
Sep	2015	The pilot conducted his BFR together with a Van's RV-7 type rating. The flight was conducted in Van's RV-7, ZK-NVS. The duration of the flight was 3.0 hours.
Jun	2016	The pilot conducted his first flight in ZK-DVS, beginning the test flight programme. At this time, the pilot had accrued approximately 275.0 hours total flight time and 3.0 hours on type.
Oct	2016	Test flights are conducted in ZK-DVS accumulating 44.7 hours of flight time. As part of the standard Sport Aircraft Association NZ Inc. ground and flight test report there is no requirement to conduct max rate turns.
Oct	2017	The pilot conducted his BFR in ZK-DVS, including both medium (30° AoB) and steep (45° AoB) turn manoeuvres. The duration of the flight was 1.5 hours.
Jan	2018	Accident flight.

Appendix 2: Accident reports

NTSB Aviation Accident Report Final Report ERA13FA424, RV-7A, N174BK:
https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20130920X04503&AKey=1&RType=Final&IType=FA

NTSB Aviation Accident Report Final Report WPR16FA036, RV-7, N307AB:
https://app.ntsb.gov/pdfgenerator/ReportGeneratorFile.ashx?EventID=20151210X74548&AKey=1&RType=Final&IType=FA

TSB Aviation Accident Report A10O0018, RV-7A, C-GNDY:
https://tsb.gc.ca/eng/rapports-reports/aviation/2010/a10o0018/A10O0018.pdf