



Australian Government

Australian Transport Safety Bureau

In-flight pitch disconnect involving ATR 72 aircraft, VH-FVR

47 km WSW of Sydney Airport, New South Wales on 20 February 2014

ATSB Transport Safety Report
Aviation Occurrence Investigation
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Background

On 20 February 2014, a Virgin Australia Regional Airlines (VARA) ATR 72 aircraft, registered VH-FVR, operating on a scheduled passenger flight from Canberra, Australian Capital Territory to Sydney, New South Wales sustained a pitch disconnect while on descent into Sydney. The aircraft was significantly damaged during the occurrence.

In accordance with the *Transport Safety Investigation Act 2003*, the ATSB initiated an investigation into the occurrence. Although the investigation is not yet complete and covers a range of areas, a safety issue has been identified that, in the interests of safety, needs to be brought to the attention of the industry before the investigation is completed. This interim report provides only the factual information and analysis associated with the identified safety issue.

This interim report complements information already provided on an update on the ATSB website on 10 June 2014.¹ It is released in accordance with section 25 of the *Transport Safety Investigation Act 2003* and is derived from the ongoing investigation of the occurrence. Readers are cautioned that new evidence may become available as the investigation progresses that will enhance the ATSB's understanding of the occurrence.

Occurrence summary

The flight departed Canberra at 1612 Eastern Daylight-saving Time² with the first officer (FO) as the pilot flying³. A steeper-than-usual climb was carried out to reduce exposure to turbulence. However, other than the expected turbulence during the first 1,500 ft, there was nothing significant during the climb to flight level (FL) 170.⁴

During cruise, the crew conducted a routine brief for the anticipated arrival to runway 16 Right, which was expected to be standard except for commencement of descent 5 NM (9 km) earlier than normal to compensate for a tailwind. The captain noted the need to be cognisant of managing airspeed during the descent as the anticipated decreasing tailwind would result in a temporary increase in the indicated airspeed.

The FO commenced descent into Sydney with the autopilot engaged in vertical speed mode and a target airspeed of 235 kt (15 kt less than the maximum operating speed of 250 kt).⁵ The descent was reported to have been initially stable and smooth.

On first contact with Sydney Approach the crew were assigned runway 16 Left. This was different to the expected runway and required the crew to re-brief the approach and change the instrument approach diagrams and navigational aid frequencies.

Passing 8,500 ft above mean sea level (AMSL), the crew noticed a rapid airspeed increase. The FO reported that the airspeed trend indicator was 'off the chart', indicating a very rapid increase in airspeed. The FO reduced engine power and used touch control steering⁶ to temporarily disconnect the autopilot before manually raising the aircraft's nose to control the speed. The FO

¹ http://www.atsb.gov.au/publications/investigation_reports/2014/aair/ao-2014-032.aspx.

² Eastern Daylight-saving Time (EDT) was Coordinated Universal Time (UTC) + 11.0 hours.

³ Pilot Flying (PF) and Pilot Monitoring (PM) are procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and aircraft flight path.

⁴ At altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 170 equates to 17,000 ft.

⁵ For information regarding the presentation of airspeed to the flight crew refer to the section titled *Airspeed indication*.

⁶ A feature of the autopilot that, in vertical speed hold mode, allows the pilot to change the vertical speed target without the need to disengage the autopilot mode. Touch control steering (TCS) is activated by pressing a switch on the control yoke. The revised vertical speed target is adjusted by manual control inputs and release of the TCS switch when the desired vertical speed is attained.

expected that, in combination, the pitch correction and power reduction would be sufficient to arrest the speed trend.

The FO reported that the aircraft felt 'heavy', as was normal for this aircraft at that speed, requiring two hands on the controls to move from the then -4° pitch angle.⁷

The captain reported being unsure if the FO's control inputs would be sufficient to avoid exceeding the maximum operating speed limitation, so put one of his hands on the controls and disconnected the autopilot to raise the nose further.

Shortly after, with both flight crew making simultaneous nose up pitch inputs on the controls, the aircraft rapidly pitched up with an associated increase in the g load.⁸ The FO responded by immediately reversing the control input to nose down. Both flight crew noticed that the controls suddenly felt different and 'spongy'. At about the same time, aural and visual cockpit warnings activated. The crew verified that the aircraft was under control at a stable attitude and speed, observing that it was level or in a slight descent at an airspeed of about 230 kt.

One of the cockpit warnings was 'pitch disconnect', indicating that the left and right elevator control systems had uncoupled from each other. This allowed for independent movement of the left and right elevators via the captain's and FO's control columns respectively.

The crew consulted the pitch disconnect checklist and worked to identify which control column was free and working normally. After determining that both controls were free, it was decided that the captain would be pilot flying for the remainder of the approach and landing at Sydney Airport. The aerodynamic loads generated during the pitch disconnect resulted in serious injury to the senior cabin crew member and significant damage to the aircraft's horizontal stabiliser (Figure 1). Although the aircraft was inspected after the pitch disconnect, the damage was not identified until 25 February 2014.

Figure 1: VH-FVR (circled) taxiing inbound at Sydney Airport on 20 February 2014 following the in-flight pitch disconnect (still image copied from closed-circuit television footage). Note the angle of the horizontal stabiliser relative to the wings



Source: Sydney Airport, modified by the ATSB

Airspeed indication

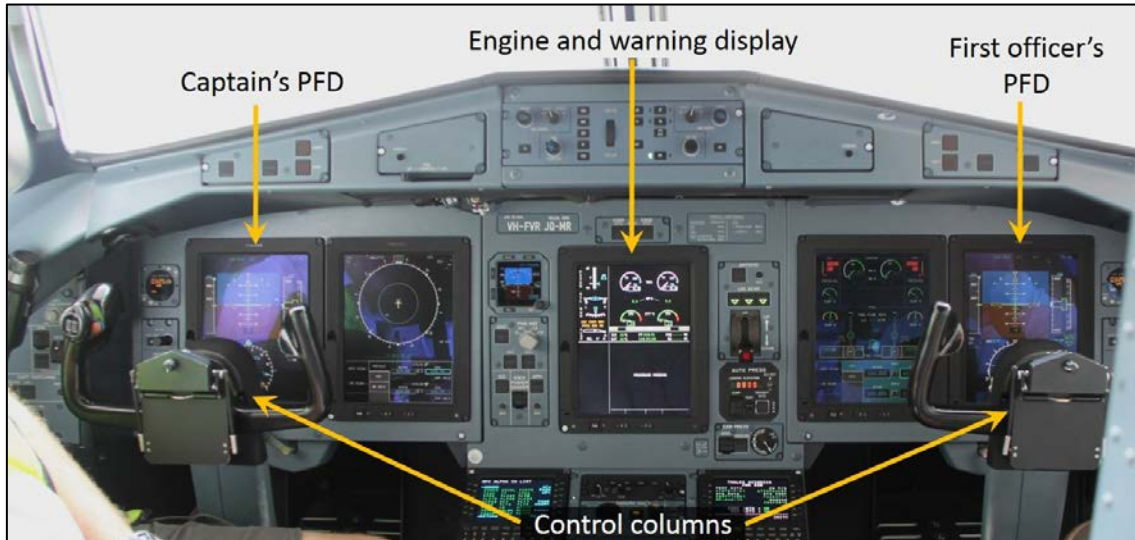
ATR 72-212A '600-series' aircraft have a 'glass cockpit' consisting of a suite of electronic displays on the instrument panel. The instrument display suite includes two primary flight displays (PFDs); one located directly in front of each pilot (Figure 2). The PFDs display information about the

⁷ Pitch is the nose-up, or nose-down attitude of the aircraft relative to a level attitude. A positive pitch angle indicates the nose is above the level attitude, whereas a negative value indicates that the nose is below the level attitude.

⁸ G Load is the nominal value for acceleration. In flight, g load values represent the combined effects of flight manoeuvring loads and turbulence. This can be a positive or negative value.

aircraft's flight mode (such as autopilot status), airspeed, attitude, altitude, vertical speed and some navigation information.

Figure 2: View of the ATR 72-212A glass cockpit showing the electronic displays. The PFDs for the captain and FO are indicated on the left and right of the instrument panel in front of the control columns



Source: ATSB

Airspeed information is provided on the left of the PFD in a vertical moving tape-style representation that is centred on the current computed airspeed. The airspeed tape covers a range of 42 kt either side of the current computed speed and has markings at 10 kt increments. The current computed airspeed is also shown in cyan figures immediately above the airspeed tape.

Important references on the airspeed indicator are shown in Figure 3, including:

- 1 Current computed airspeed
- 2 Airspeed trend

Indicates the predicted airspeed in 10 seconds if the acceleration remains constant. The trend indication is represented as a yellow arrow that extends from the current airspeed reference line to the predicted airspeed.

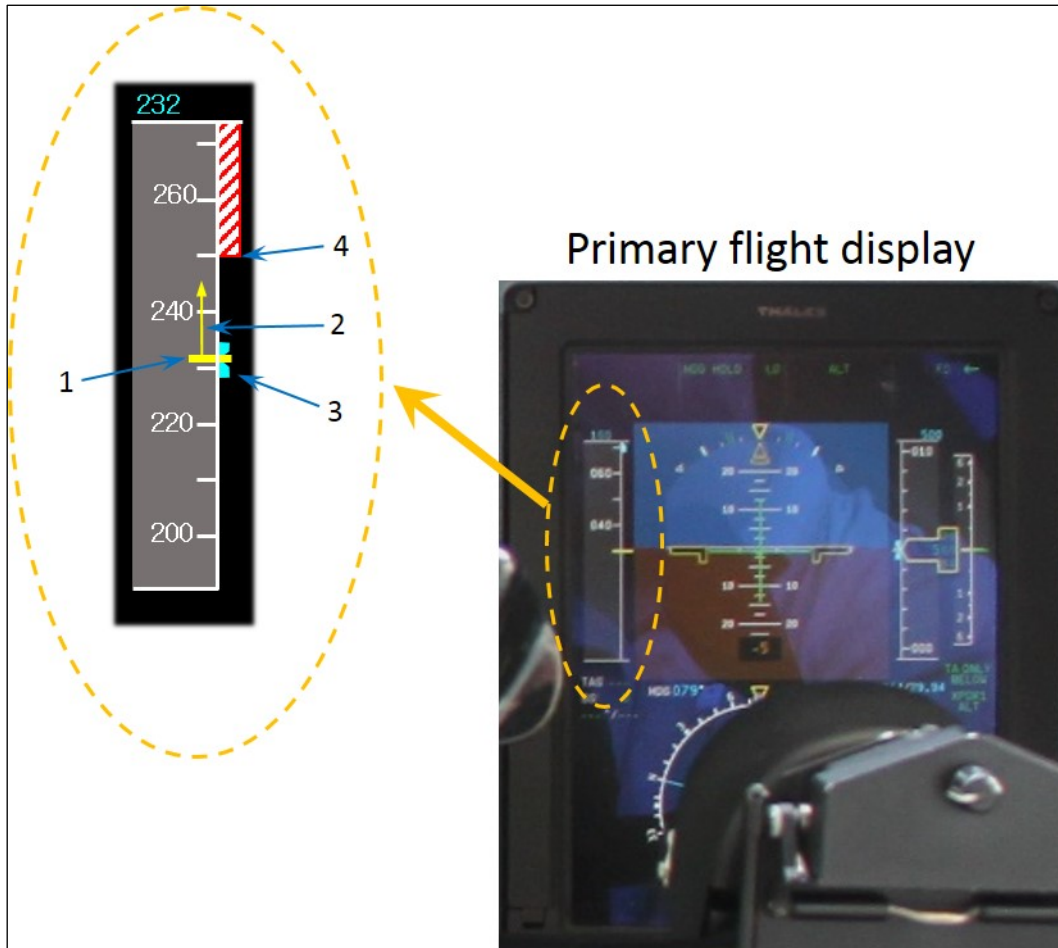
- 3 Target speed bug

Provides the target airspeed and can be either computed by the aircraft's systems, or selected by the flight crew.

- 4 Maximum airspeed – speed limit band

Indicates the maximum speed not to be exceeded in the current configuration. The example shown shows the maximum operating speed of 250 kt.

Figure 3: Representation of the airspeed indicator on the PFD. The example shows a current computed airspeed of 232 kt (represented by a yellow horizontal line) with an increasing speed trend that is shown in this case as a vertical yellow arrow and is approaching the maximum speed in the current configuration of 250 kt. Note: the airspeed information shown in the figure is for information only and does not represent actual values from the occurrence flight



Source: ATSB

Flight control system

The ATR 72 primary flight controls essentially consist of an aileron and spoiler on each wing, two elevators and a rudder. All of the controls except the spoilers are mechanically actuated.

Pitch control system

The pitch control system is used to position the elevators to control the direction and magnitude of the aerodynamic loads generated by the horizontal stabiliser. The system consists of left and right control columns in the cockpit connected to the elevators via a system of cables, pulleys, push-pull rods and bell cranks (Figure 4). The left (captain's) and right (FO's) control systems are basically a copy of each other, where the left system connects directly to the left elevator and the right system connects directly to the right elevator.⁹

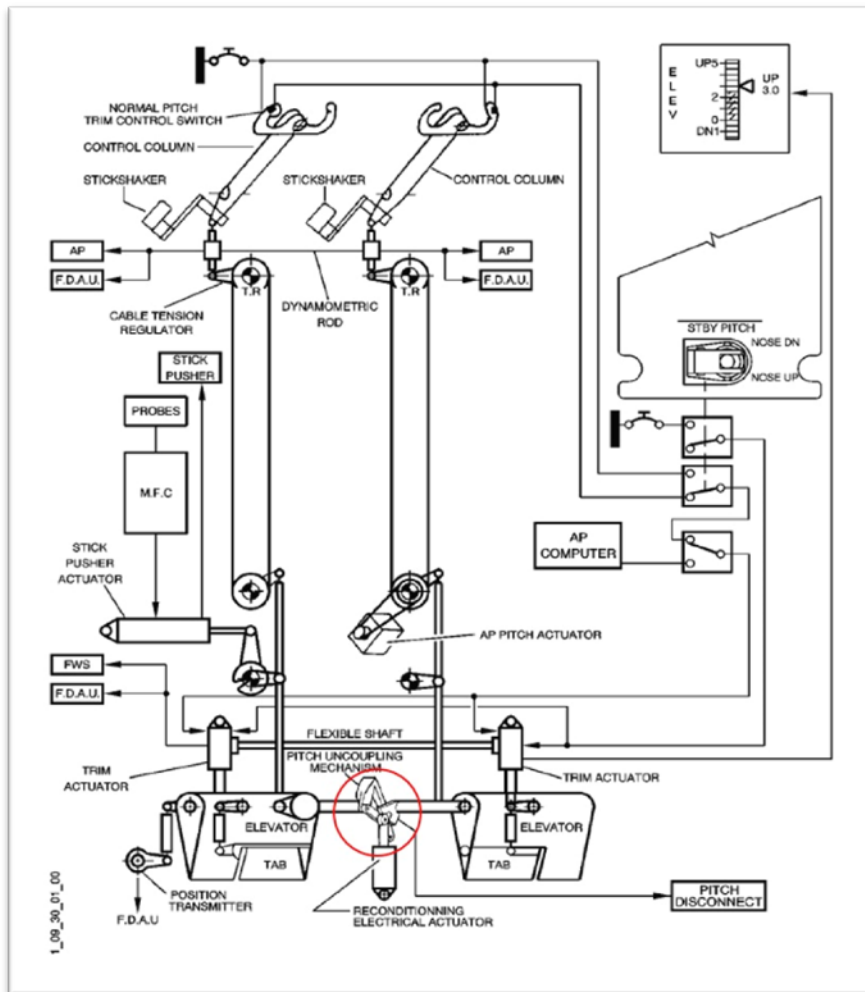
In normal operation, the left and right systems are connected such that moving one control column moves the other control column in unison. However, to permit continued control of the aircraft in the event of a jam within the pitch control system, a pitch uncoupling mechanism is incorporated

⁹ The primary differences between the left and right sides are that the stick-pusher (part of the stall prevention system) is connected to the left system only and the autopilot pitch actuator is connected to the right system only.

into the aircraft design that allows the left and right control systems to disconnect and operate independently.¹⁰ That mechanism comprises a spring-loaded system located between the left and right elevators.

The forces applied on one side of the pitch control system are transmitted to the opposite side as a torque or twisting force through the pitch uncoupling mechanism. The pitch uncoupling mechanism activates automatically when this torque reaches a preset level, separating the left and right control systems. When set correctly, the activation torque is equivalent to opposing forces of 50 to 55 daN (about 51 to 56 kg force) being simultaneously applied to each control column.

Figure 4: ATR 72 elevator/pitch control system with the pitch uncoupling mechanism circled in red



Source: ATR, annotated by the ATSB

Activation of the pitch uncoupling mechanism is signalled in the cockpit by the master warning light flashing red, a continuous repetitive chime aural alert and a flashing red PITCH DISC message on the engine and warning display (Figure 5).¹¹ The associated procedure to be followed in response to activation of the pitch uncoupling mechanism is presented to the right of the warning message.

¹⁰ This satisfied item 25.671 of the Joint Aviation Requirements (JAR) 25, part of the design standard to which the aircraft was certified. JAR 25.671 required that 'The aeroplane must be shown by analysis, test or both, to be capable of continued safe flight and landing after [certain] failures or jamming of the flight control system and surfaces within the normal flight envelope, without requiring exceptional piloting skill or strength.'

¹¹ The engine and warning display is located in the middle of the instrument panel, refer to Figure 2.

Figure 5: Pitch disconnect warning presentation on the engine and warning display. The red PITCH DISC warning message, indicated by the thick yellow arrow, is located on the lower left of the screen. The pitch disconnect procedure is displayed to the right of the warning message



Source: ATSB

The pitch uncoupling mechanism can be reset by the flight crew, reconnecting the left and right elevator systems. However, this can only be achieved when the aircraft is on the ground.

ATR advised that, because a jammed pitch control channel¹² can occur in any phase of flight, a spring-loaded pitch uncoupling mechanism was selected over a directly-controlled mechanism. The logic of this approach was that this type of mechanism provides an intuitive way to uncouple the two pitch channels and recover control through either channel. ATR also advised that a directly-controlled uncoupling mechanism increased the time necessary for a pilot to identify the failure, apply the procedure and recover pitch authority during a potentially high pilot workload phase (such as take-off or the landing flare).

System testing

During examination of the aircraft by the ATSB, the pitch uncoupling mechanism was tested in accordance with the aircraft's maintenance instructions. The load applied to the control column to activate the pitch uncoupling mechanism was found to be at a value marginally greater than the manufacturer's required value. The reason for this greater value was not determined, but may be related to the damage sustained during the pitch disconnect event.

Aircraft damage

Examination of the aircraft by the ATSB and the aircraft manufacturer identified significant structural damage to the horizontal stabiliser. This included:

- external damage to the left and right horizontal stabilisers (tailplanes) (Figure 6)
- fracture of the composite structure around the rear horizontal-to-vertical stabiliser attachment points (Figure 7)
- fracture of the front spar web (Figure 8)
- cracking of the horizontal-to-vertical stabiliser attachment support ribs

¹² The left and right systems are referred to as pitch control channels.

- cracking of the attachment support structure
- cracking and delamination of the skin panels at the rear spar (Figure 9).

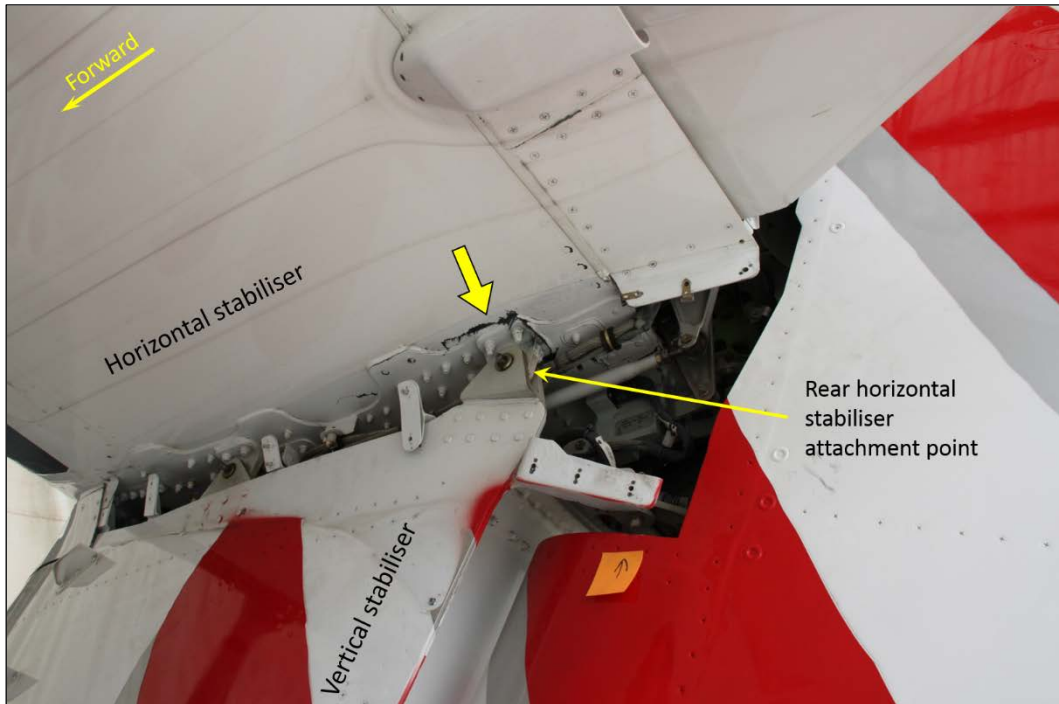
Following assessment of the damage, the manufacturer required replacement of the horizontal and vertical stabilisers before further flight.

Figure 6: Tailplane external damage (indicated by marks and stickers) with the aerodynamic fairings installed



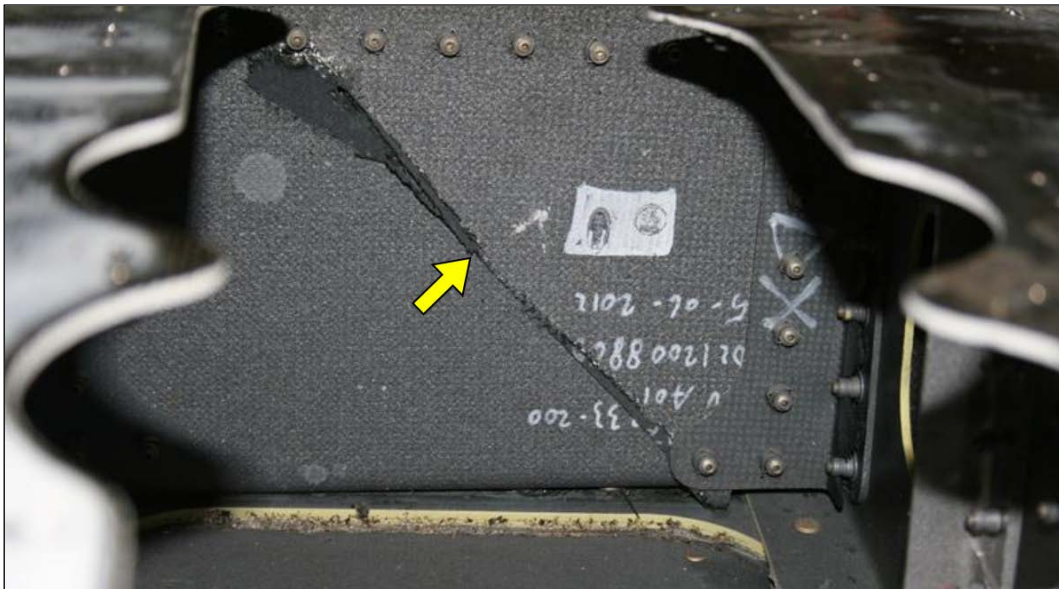
Source: ATSB

Figure 7: Horizontal-to-vertical stabiliser attachment with the aerodynamic fairings removed. View looking upwards at the underside of the horizontal stabiliser. The thick yellow arrow indicates cracking in the composite structure around the rear attachment point



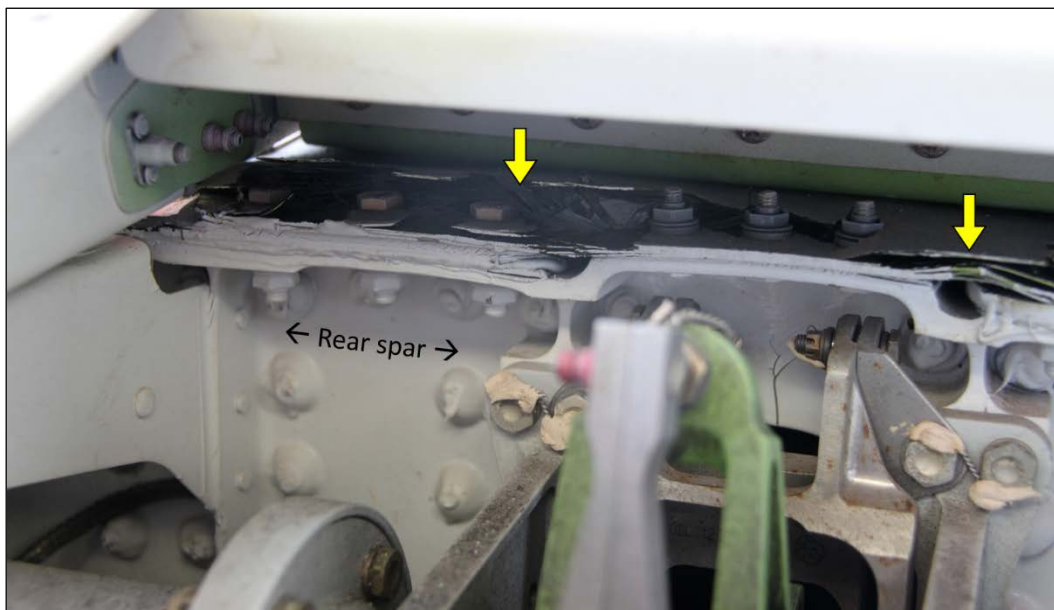
Source: ATSB

Figure 8: Crack in the horizontal stabiliser front spar. The diagonal crack in the spar web is identified by a yellow arrow



Source: ATR, modified by the ATSB

Figure 9: Cracking and delamination of the upper skin on the horizontal stabiliser at the rear spar. View looking forward at the rear face of the rear spar. Damage identified by yellow arrows



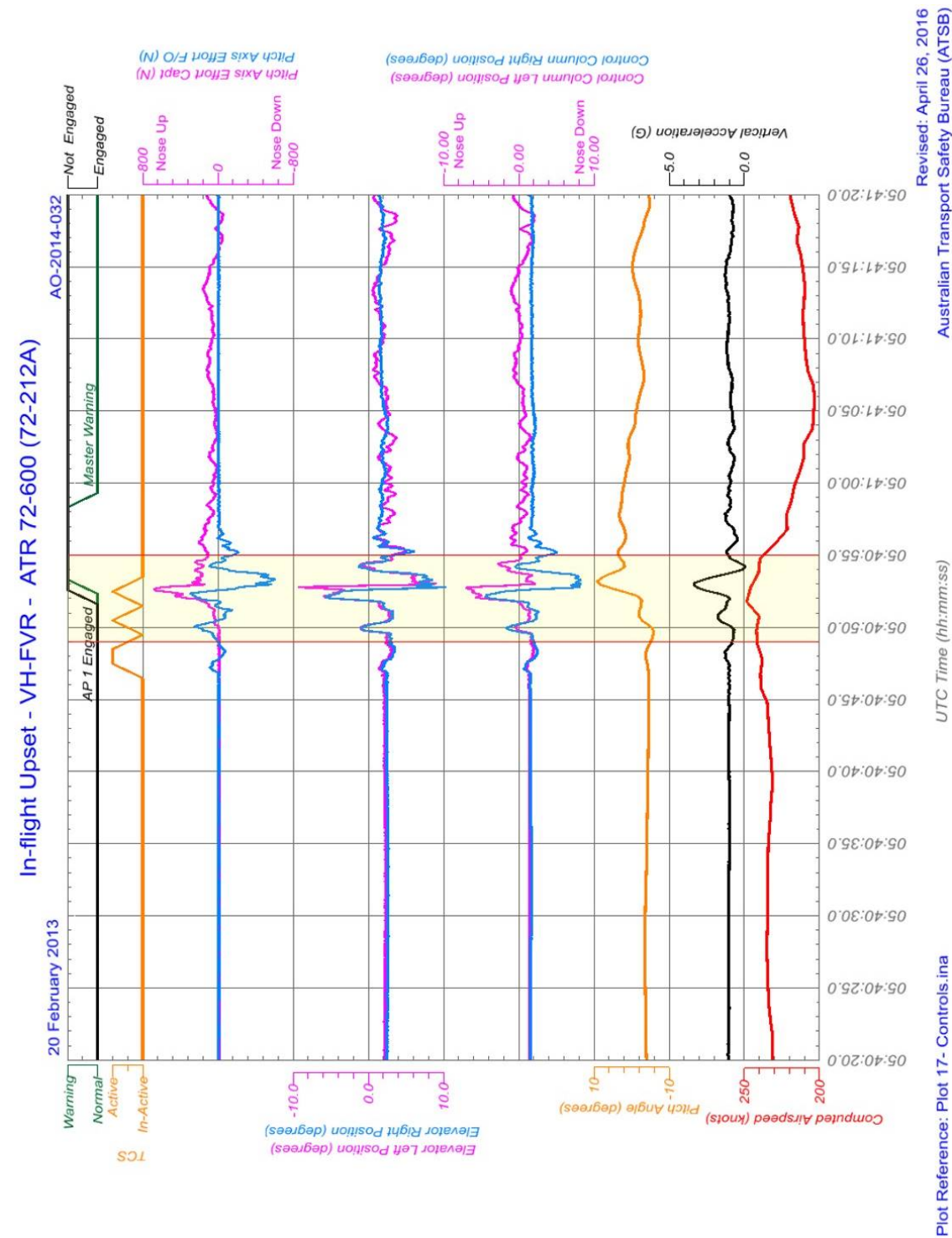
Source: ATSB

Recorded data

The ATSB obtained recorded information from the aircraft's flight data recorder (FDR) and cockpit voice recorder (CVR). Graphical representations of selected parameters from the FDR are shown in Figures 10 and 11 as follows:

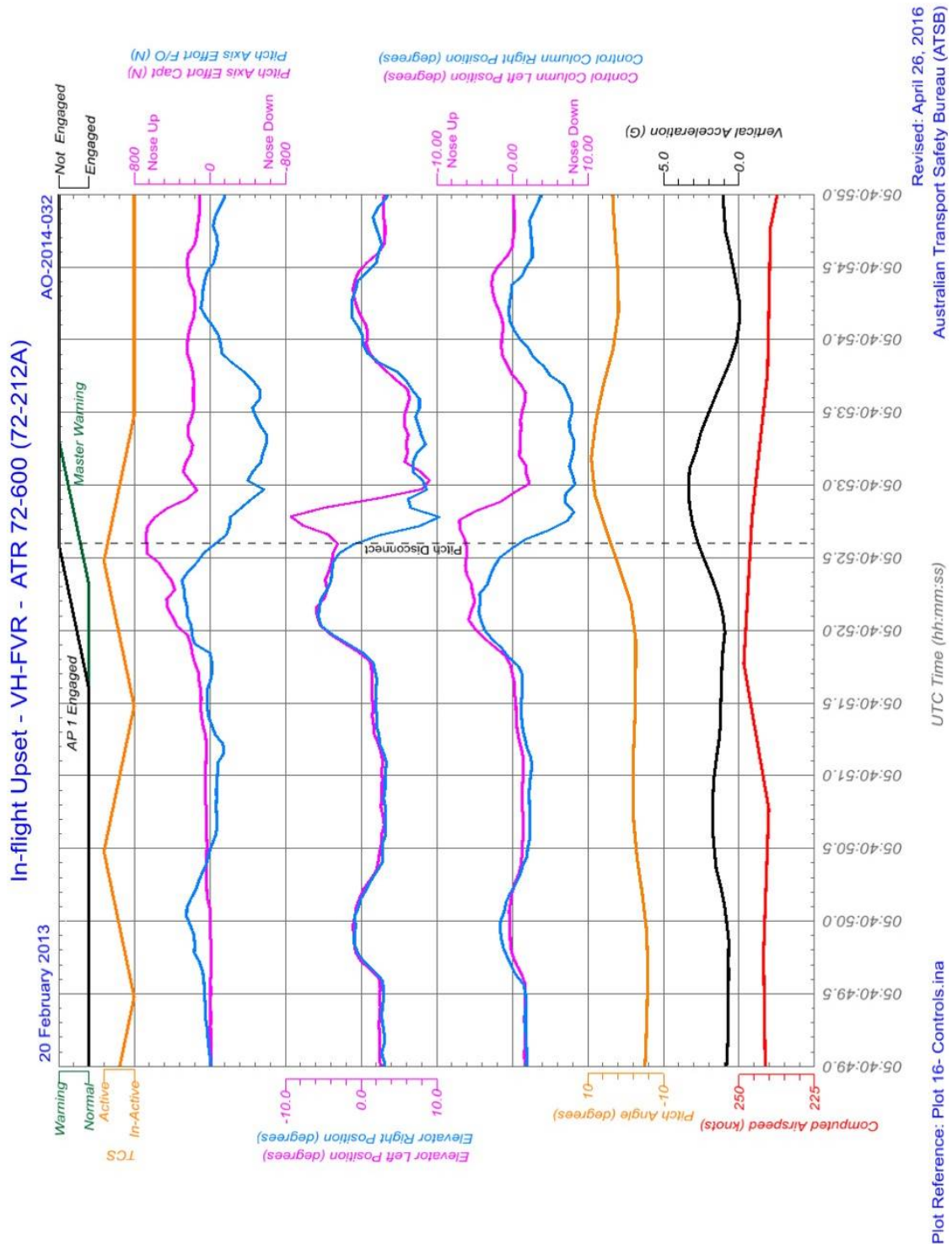
- Figure 10 shows selected data for a 60-second time period within which the occurrence took place. This includes a shaded, 6-second period that shows the pitch disconnect itself.
- Figure 11 shows an expanded view of the 6-second period in which the pitch disconnect took place.

Figure 10: FDR information showing the relevant pitch parameters for a period spanning about 30 seconds before and after the pitch disconnect



Source: ATSB

Figure 11: FDR information showing the relevant pitch parameters for the shaded 6-second period in Figure 10 during which the pitch disconnect took place. The estimated time of the pitch disconnect is shown with a black dashed line at time 05:40:52.6



Source: ATSB

In summary, the recorded data shows that:

- leading up to the occurrence, there was no indication of turbulence
- the autopilot was engaged and controlling the aircraft
- leading up to the uncoupling, both elevators moved in unison

- in the seconds leading up to the occurrence, there were a number of rapid increases in the recorded airspeed
- the FO made three nose up control inputs correlating with the use of the touch control steering
- at about time 05:40:50.1, or about 2.5 seconds before the pitch disconnect, a small load (pitch axis effort) was registered on the captain's pitch control
- the captain started to make a nose up pitch input shortly before the FO made the third nose up input
- when the FO started moving the control column forward (nose down) at about 05:40:52.3, the load on the captain's control increased (nose up) at about the same rate that the first officer's decreased
- at 05:40:52.6 the elevators uncoupled. At that time:
 - the load on the captain's control column was 67 daN and on the FO's -8.5 daN
 - the aircraft pitch angle was increasing
 - the vertical acceleration was about +2.8g and increasing
- after this time, the elevators no longer moved in unison
- peak elevator deflections of +10.4° and -9.3° were recorded about 0.2 seconds after the pitch disconnect
- about 0.25 seconds after the peak deflections, the captain moved the control forward until both elevators were in similar positions
- a maximum vertical acceleration of 3.34g was recorded at about 05:40:53.0
- the master warning activated after the pitch disconnect.¹³

A number of features in the recorded data were used to identify the most likely time the pitch uncoupling mechanism activated, resulting in the pitch disconnect (black dashed line in Figure 11). This included when the elevator positions show separation from each other and reversal of the left elevator position while the left control column position remained relatively constant.

Although not shown in the previous figures, the yaw axis effort (pilot load applied to the rudder pedals), indicated that the applied load exceeded the value that would result in the automatic disconnection of the autopilot.¹⁴ That load exceedance occurred at 05:40:51.9, about the time that the autopilot disconnected. However, due to the data resolution and lack of a parameter that monitored the pilot's disconnect button, it could not be determined if the autopilot disconnection was due to the load exceedance or the manual disconnection reported by the captain.

The CVR captured auditory tones consistent with the autopilot disconnection and the master warning. The first verbal indication on the CVR of flight crew awareness of the pitch disconnect was about 6 seconds after the master warning activated.

Manufacturer's load analysis

ATR performed a load analysis based on data from the aircraft's quick access recorder that was supplied by the operator. That analysis showed that during the pitch disconnect occurrence:

¹³ The FDR parameter recording the master warning recorded at 1-second intervals, whereas the flight control parameters were recorded 16 times per second. This difference in recording resolution may result in the FDR data showing an apparent lag between the pitch uncoupling and activation of the master warning.

¹⁴ The autopilot system has a feature that will automatically disconnect the autopilot if the flight crew exceed preset control forces. This allows the flight crew to assume full control without the need to manually disconnect the autopilot.

- the limit load¹⁵ for the:
 - vertical load on the horizontal stabiliser was exceeded
 - vertical load on the wing was reached
 - bending moment on the wing was exceeded
 - engine mounts were exceeded.
- the ultimate load,¹⁶ in terms of the asymmetric moment¹⁷ on the horizontal stabiliser, was exceeded.

ATR's analysis found that the maximum load on the horizontal stabiliser coincided with the maximum elevator deflection that occurred 0.125 seconds after the elevators uncoupled. At that point, the ultimate load was exceeded by about 47 per cent, and the exceedance lasted about 0.125 second.

History of ATR 42/72 pitch disconnect occurrences

On the ground

The ATR42/72 aircraft type had a history of occasional pitch disconnects on the ground. ATR analysed these occurrences and established that in certain conditions, applying reverse thrust on landing could lead to excitation of a structural vibration mode close to the elevators' anti-symmetric vibration mode. This could result in a disconnection between the pitch control channels. These type of on-ground events have not resulted in aircraft damage.

Tests were performed by ATR to determine the conditions in which those events occur. It appeared that the conditions include a combination of several factors: reverse thrust application, wind conditions and crew action on the control column.

In-flight

The ATSB requested occurrence data on recorded in-flight pitch disconnections from ATR in late 2014 and received that data in late 2015. ATR provided occurrence details and short summaries for 11 in-flight pitch disconnect occurrences based on operator reports. The summaries indicated a number of factors that resulted in the pitch disconnects, including encounters with strong turbulence, mechanical failure and some where the origin of the pitch disconnect could not be established. However, for the purposes of this investigation, the ATSB has focussed on those occurrences where opposite pitch inputs (simultaneous nose down/nose up) were identified as primarily contributing to the occurrences.

Opposite efforts applied on both control columns

Three occurrences were identified where a pitch disconnect occurred as a result of the flight crew simultaneously applying opposite pitch control inputs. At the time of this interim report, two of the three occurrences are under investigation by other international agencies, so verified details of the occurrences are not available.

In the occurrence that is not being investigated, the operator reported to ATR that during an approach, severe turbulence was encountered and the pitch channels disconnected. Although the recorded flight data did not contain a direct record of the load applied by each pilot, ATR's analysis determined that the pitch disconnect was most likely due to opposing pitch inputs made by the flight crew.

¹⁵ According to JAR 25.301, the limit load is the maximum load to be expected in service. JAR 25.305 requires that the aircraft structure must be able to support the limit load without detrimental permanent deformation.

¹⁶ According to JAR 25.301, the ultimate load is the limit load multiplied by a prescribed factor of safety. JAR 25.305 requires that the aircraft structure must be able to support the ultimate load without failure for at least 3 seconds.

¹⁷ A moment is the turning effect from a force. It is the product of the force multiplied by the perpendicular distance from the line of action of the force to the pivot point.

In addition, there were two occurrences where a pitch disconnect occurred due to opposing crew pitch inputs; however, the primary factor was a loss of control after experiencing in-flight icing. The pitch disconnects occurred while the flight crew were attempting to regain control of the aircraft. In one of these occurrences, the horizontal stabiliser separated from the aircraft before it impacted with the terrain. In the other, the flight crew regained control of the aircraft.

Jammed flight controls

ATR reported that they were not aware of any pitch disconnects associated with a jammed pitch control system.

A review of past occurrences by the ATSB identified one partial jammed pitch control that occurred in the United States on 25 December 2009. According to the United States National Transportation Safety Board investigation into the occurrence 'The flight crew twice attempted the Jammed Elevator procedure in an effort to uncouple the elevators. Despite their attempts they did not succeed in uncoupling the elevators.'¹⁸

Investigation activities to date

To date, the ATSB has collected information about, and analysed the following:

- the sequence of events before and after the pitch disconnect, including the post-occurrence maintenance and initial investigation by Virgin Australia Regional Airlines (VARA) and ATR
- flight and cabin crew training, qualifications, and experience
- the meteorological conditions
- VARA policy and procedures
- VARA training courses
- VARA's safety management system
- VARA's maintenance program
- the aircraft's systems
- the relationship between VARA and the maintenance organisation
- maintenance engineer training, qualifications, and experience
- the maintenance organisation's policy and procedures
- the maintenance organisation's training courses
- the maintenance organisation's quality and safety management
- the Civil Aviation Safety Authority's (CASA) surveillance of VARA
- CASA's approvals granted to VARA
- CASA's surveillance of the maintenance organisation
- CASA's approvals granted to the maintenance organisation
- ATR's flight crew type training
- ATR's maintenance engineer type training
- ATR's maintenance instructions for continuing airworthiness
- known worldwide in-flight pitch disconnect occurrences involving ATR 42/72 aircraft.

¹⁸ United States National Transportation Safety Board identification: CEN10IA084

Safety analysis and finding

Analysis

The actions taken by the flight crew were consistent with an attempt to prevent an increase in the aircraft's speed. It was not consistent with a conscious attempt to disconnect the left and right elevator systems due to a control jam.

The force differential between the captain's and first officer's pitch control inputs when the pitch uncoupling mechanism activated was about 75 daN. This was less than the expected combined load of about 50 to 55 daN each (that is, a total differential of about 100 to 110 daN), and would initially suggest that the pitch uncoupling mechanism may have activated below the designed force differential. However, post-occurrence testing conducted for the ATSB identified that the pitch uncoupling force exceeded the requirement. It is therefore unlikely that the pitch disconnect was due to a pitch uncoupling mechanism malfunction or incorrect activation setting. The difference in activation loads will be examined further in the final report.

The recorded data from the flight showed that both flight crew made simultaneous but opposite direction control inputs at the time of the pitch disconnect. Thus, it is most likely that the pitch disconnect was a result of an inadvertent application of opposing control inputs by the flight crew while attempting to prevent an exceedance of the aircraft's maximum operating speed. The factors that led to both flight crew members making those control inputs will be examined in detail in the final report.

At the time of the pitch disconnect, the aircraft was near its maximum permitted operating speed. Because of this high speed, the resulting asymmetric elevator deflections resulted in a large asymmetric aerodynamic load being generated on the horizontal stabiliser. That load exceeded the design strength requirements for the stabiliser structure, resulting in significant damage. Such a large exceedance has the potential to result in catastrophic damage to the stabiliser and a subsequent loss of control.

Despite pre-existing, well-established and trained procedural risk controls to prevent dual control inputs in normal operation, the risk controls were readily, but inadvertently, bypassed by the crew on this occasion. The factors that led to this situation will be examined in detail in the final report. However, it shows that the aircraft was in a situation where inadvertent control inputs could lead to catastrophic failure of the horizontal stabiliser.

In normal operation, flight crew should not be making uncoordinated simultaneous control inputs. However this, and a number of other in-flight pitch disconnect occurrences, indicate that the pre-existing procedural risk controls alone may not be sufficient to prevent this type of occurrence. Also, on this occasion, significant structural damage was done to the aircraft before the crew were alerted to, and able to react to the disconnection of the left and right pitch systems. Consequently, the ATSB is investigating whether the design of the pitch control and associated warning systems increases the likelihood of potentially catastrophic damage occurring when flight crew inadvertently make opposing pitch control inputs. The final report will contain a detailed assessment of this aspect of the investigation.

Finding

Based on the circumstances of this and a number of similar occurrences, the ATSB makes the following finding:

- **Inadvertent application of opposing pitch control inputs by flight crew can activate the pitch uncoupling mechanism which, in certain high-energy situations, can result in catastrophic damage to the aircraft structure before crews are able to react. [Safety issue]**

Safety issue and actions

The ATSB expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

In this case, the ATSB has assessed that the risk posed by the safety issue is of sufficient magnitude to warrant the release of an interim report. This action provides the earliest opportunity for the relevant organisation to initiate proactive safety action, rather than to wait for the final investigation report to be published.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of this and any other safety issues and actions identified by the ATSB are repeated separately on the ATSB website to facilitate monitoring by interested parties. Where relevant the safety issues and actions will be updated on the ATSB website as information comes to hand.

Inadvertent activation of the elevator control system - pitch uncoupling mechanism

Number:	AO-2014-032-SI-01
Issue owner:	ATR
Operation affected:	Aviation: Air transport
Who it affects:	All operators of ATR 42 and ATR 72 aircraft

Safety issue description:

Inadvertent application of opposing pitch control inputs by flight crew can activate the pitch uncoupling mechanism which, in certain high-energy situations, can result in catastrophic damage to the aircraft structure before crews are able to react.

Background to the safety issue

Initially, the ATSB was unaware of any other in-flight pitch disconnect occurrences on the ATR 42/72 series aircraft. As a result, the existing procedural risk controls were considered effective at maintaining a sufficiently low probability of a recurrence of the occurrence involving VH-FVR on 20 February 2014. As such, the ATSB did not initially consider that immediate safety action was necessary.

However, once aware of other in-flight pitch disconnect occurrences, none of which were because of a jammed system, it became apparent that the related procedural risk controls were not sufficiently effective. The likelihood of an inadvertent in-flight pitch disconnect has been demonstrated to be higher than the initial assessment suggested.

Proactive safety action by ATR

As a result of this occurrence and a briefing from the ATSB on 5 February 2016 on the safety issue, ATR released an All Operators Message (AOM). The message informed operators of ATR 42/72 aircraft of revised maintenance and operational documentation relating to the pitch control system and pitch disconnect occurrences as follows:

ATR conducted a review of both maintenance and operational documentation related to Pitch Disconnection and as a result, launched the following actions:

- The creation of a dedicated Job Instruction Card (JIC 55-10-00-DVI-10000) to perform a Detailed Visual Inspection (DVI) after any reported pitch disconnection in flight.
- ATR is contacting customers operating aircraft for which a pitch disconnect in flight occurrence was reported in the past, to request the above mentioned inspection.
- The revision of the JIC dedicated to the re-clutching of the pitch uncoupling mechanism (27-31-42-REA-10000) to call for the new DVI for any reported pitch disconnection in flight.
- The revision of the FCOM and QRH "Procedures following failure – Flight Control - Pitch disconnect" instructing for maintenance action before reconnecting the system after a disconnection in flight.
- The revision of the AFM supplement "FERRY FLIGHT WITH PITCH ELEVATORS DISCONNECTED" instructing for maintenance action before dispatch.
- The revision of the FCOM "Procedures and Techniques – Flight Controls – Pitch" to include the following:

In flight aggressive or large elevator input at high speed should be avoided. Such inputs can lead to high loads and can result in structural damage to the horizontal stabilizer.

To maintain aircraft controllability in case of control surface jamming, elevators can be uncoupled.

Elevators uncoupling :

- *requires the application of a high effort (52 daN/114 lbs) between both control columns (to minimize the risk of untimely disconnection).*
- *triggers a red warning « PITCH DISCONNECT » on the CAP.*
- *allows the flight to be safely completed: refer to procedures following failures.*

Caution : *Dual input in opposite direction may result in a pitch disconnect.*

In any of the following configurations, the aircraft must be controlled from one control column only :

- *Normal configuration, both elevators connected*
- *Pitch Disconnect with one elevator jammed*
- *Pitch disconnect without any elevator jammed*

In the event of a pitch disconnect without any jamming, the pilot monitoring input on the other control column may disturb aircraft controllability feedback for the pilot flying. Without any input on the control column, the unused elevator will stay at null aerodynamic effort.

In relation to the continuing airworthiness of aircraft reported to have previously sustained an in-flight pitch disconnect, ATR reported that they had contacted the relevant operators to ensure that all of the affected aircraft were subject to the new detailed visual inspections.

Proactive safety action by Virgin Australia Regional Airlines and Virgin Australia Airlines¹⁹

Virgin Australia Airlines advised that, in response to this occurrence, they had taken action to reduce the potential for pitch disconnects and to manage the risk of adverse outcomes from such occurrences. These included:

- reviewing and revising (where necessary) policy and procedures associated with descent speeds, handover and takeover procedures, overspeed recovery and on ground pitch disconnects
- incorporation of a number of factors surrounding the event into training material and simulator checks
- improved pilot awareness through Flight Crew Operations Notices, manufacturer's communications (All Operators Messages) and ongoing training and checking
- updated maintenance requirements following a pitch disconnect.

Proactive safety action by Toll Aviation and Toll Aviation Engineering

Toll Aviation and Toll Aviation Engineering advised that, as a result of this occurrence, they issued a safety alert to their flight crew and aviation maintenance engineers. This alert advised that, in the event of a pitch disconnect, the aircraft was to be grounded until the appropriate checks had been carried out.

¹⁹ Since the pitch disconnect occurrence, Virgin Australia Airlines had taken over operation of the ATR 72 fleet from VARA.

Australian Transport Safety Bureau

The ATSB is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.