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AAIB CORRESPONDENCE INVESTIGATIONS (Continued)

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation reports

SERIOUS INCIDENT

Aircraft Type and Registration:	1) Airbus A300-605R, TC-MNV 2) Boeing Vertol CH-47D Chinook HC2, ZA720
No & Type of Engines:	1) 2 General Electric CF6-80C2 turbofan engines 2) 2 Honeywell T55-GA-712 turboshaft engines
Year of Manufacture:	1) 1999 2) Not known
Date & Time (UTC):	18 November 2011 at 1505 hrs
Location:	Near RAF Brize Norton Aerodrome, Oxfordshire
Type of Flight:	1) Commercial Air Transport 2) Military
Persons on Board:	1) Crew - 3 Passengers - None 2) Crew - 4 Passengers - None
Injuries:	1) Crew - None Passengers - N/A 2) Crew - None Passengers - N/A
Nature of Damage:	1) None 2) None
Commander's Licence:	1) Airline Transport Pilot's Licence 2) Military command qualification
Commander's Age:	1) 44 years 2) 29 years
Commander's Flying Experience:	1) 7,334 hours (of which 135 were on type) Last 90 days - 135 hours Last 28 days - 66 hours 2) 1,500 hours (of which 500 were on type) Last 90 days - 80 hours Last 28 days - 20 hours
Information Source:	AAIB Field Investigation

Synopsis

The crew of the A300 were cleared to depart from RAF Brize Norton on a Malby Standard Instrument Departure (SID), which required them to climb to FL080. The departure clearance was issued on the ground radio frequency. When the crew changed to the tower frequency a Climb-out Restriction (COR) of 2,200 ft on the airfield QNH was imposed by ATC, to provide vertical separation from a military Chinook helicopter in the holding pattern above the airfield. The COR instruction, which was not standard RT phraseology, was misinterpreted by the A300 crew. The A300 aircraft did not level off at 2,200 ft after departure but climbed through the level of the Chinook. The returns from the two aircraft were seen to merge on the ATC radar

display. The A300 crew received a TCAS Resolution Advisory (RA), which they followed.

According to TCAS data from the A300, the minimum lateral separation between the A300 and the Chinook was 0.11 nm and the minimum vertical separation was 496 ft. Two Safety Recommendations are made with the intention of preventing similar incidents in the future.

History of the flight

Chinook helicopter

The crew of the military Chinook helicopter were carrying out instrument flying training and were tracking 307°(T), inbound to the Brize Norton (BZ) NDB, to take up the holding pattern. The holding pattern is a standard, right hand hold with an inbound heading of 100°. This required the crew to perform a parallel join, followed by a left turn to return to the BZ. The helicopter, which was equipped with a Mode S transponder but squawking Mode C, was flying at 3,000 ft on the Cotswold QNH of 1010 hPa. The crew were instructed by ATC to set the Brize Norton QFE of 1005 hPa, adjust their height to 3,000 ft on that setting and contact the Brize Norton Director on 133.750 MHz. In order to provide vertical separation from a departing Airbus A300, the Chinook crew were then instructed to climb to 3,500 ft on the QFE.

After passing over the BZ NDB, the Chinook tracked 280° outbound from the beacon at 3,500 ft on the QFE. A level, rate one turn to the left was then initiated to return to the BZ. As the helicopter continued the turn towards the south, crew members saw the A300 pass over them. The Chinook crew filed an Airprox report following the incident.

Airbus A300

The A300 arrived from Istanbul that morning and was carrying out a return, freight-only flight to Istanbul Sabiha Gokcen International airport in Turkey. The crew comprised two pilots and a loadmaster. The aircraft commander was the pilot handling and the co-pilot was the pilot monitoring; his duties included radio communications. It was the commander's first rotation through Brize Norton, but the co-pilot had been there a number of times before. Both were Turkish nationals with a good working knowledge of English.

Having completed their preparations and started engines, the crew requested taxi clearance at 1452:09 hrs on the Ground frequency of 121.725 MHz. The weather was QFE 1005 hPa, QNH 1015 hPa, visibility greater than 10 km, few clouds at 1,800 ft, broken cloud at 12,000 ft and 25,000 ft, surface wind 180° at 08 kt. The clearance, initially, was to holding point Delta for Runway 26, but in order to give way to another aircraft, the A300 was held at its parking position. Once the other aircraft was clear the A300, callsign 'Blacksea 508', was cleared to taxi to holding point Echo for Runway 26. The crew commenced taxiing at 1457:00 hrs and at 1458:29 hrs the ground controller transmitted their departure clearance:

> "BLACKSEA FIVE ZERO EIGHT AFTER DEPARTURE CLIMB MALBY SID, FLIGHT LEVEL EIGHT ZERO. SQUAWK FIVE TWO ONE ZERO AND WITH BRIZE APPROACH ONE TWO SEVEN DECIMAL TWO FIVE ZERO".

The crew responded:

> "CLEARED VIA MALBY SID, FLIGHT LEVEL ZERO EIGHT ZERO AND AFTER DEPARTURE ONE TWO SEVEN TWO FIVE. CONFIRM TO SQUAWK FIVE TWO ONE ZERO?"

The ground controller confirmed the squawk and the crew activated the departure in the Flight Management System (FMS) with 8,000 ft selected as the target altitude. The departure had been briefed and the commander intended to use the autopilot engaged with the 'Profile Mode' to be selected after takeoff. In this mode the autopilot follows the horizontal and vertical profile of the departure and levels off at the target altitude.

The crew calculated that there was sufficient runway length available from the Echo holding point intersection for their takeoff and offered to depart from there. The ground controller acknowledged this and instructed them to hold at Echo and change to the tower frequency of 123.725 MHz.

Having changed frequency, the next information the crew were expecting to be passed was either to line up at Echo or to continue the taxi to holding point Foxtrot, from which the full length of the runway is available for takeoff.

The crew contacted the tower controller on the dedicated frequency and the Radiotelephony (RT) exchange detailed in Table 1 took place between the co-pilot and the tower controller.

During this exchange the crew, who were expecting taxiway and runway related information, interpreted the 2,200 ft to be the runway length reduction when entering the runway from holding point Echo. Although both pilots were familiar with the term 'Climb-out Restriction', they did not register the information as an altitude and therefore did not read back the phrase.

The aircraft entered Runway 26 from holding point Echo and was cleared for takeoff at 1505:02 hrs. At 1506:13 hrs the crew were instructed to contact Brize Norton Approach.

The crew contacted the approach controller at 1506:16 hrs. Table 2 contains a transcript of the radio exchange that then took place.

TO	FROM	RT TRANSMISSION	TIME
MNB 508	TWR	BLACK SEA FIVE ZERO EIGHT, CLIMB OUT RESTRICTION TWO THOUSAND TWO HUNDRED FEET ON BRIZE QNH ONE ZERO ONE FIVE ACKNOWLEDGE	15:03:13
TWR	MNB508	ONE ZERO ONE FIVE COPIED, WE ARE ALSO ABLE TO TAKE THE ECHO FOR, FOR DEPARTURE	15:03:19
MNB 508	TWR	BLACK SEA FIVE ZERO EIGHT, JUST CONFIRM CLIMB OUT RESTRICTION TWO THOUSAND TWO HUNDRED FEET ON ONE ZERO ONE FIVE	15:03:26
TWR	MNB 508	YES GOOD COPIED, THANK YOU	15:03:30
MNB 508	TWR	SEA 50, I NEED YOU TO SAY BACK, CLIMB OUT RESTRICTION TWO THOUSAND TWO HUNDRED FEET	15:03:35
TWR	MNB 508	YEAH, TWO THOUSAND TWO HUNDRED FEET COPIED	15:03:40
MNB 508	TWR	SEA FIVE ZERO, VIA ECHO LINE UP AND WAIT	15:03:44

Table 1

RT exchange prior to takeoff

TO	FROM	RT TRANSMISSION	TIME
APP	MNB 508	BRIZE DEPARTURE GOOD AFTERNOON BLACK SEA FIVE ZERO EIGHT AIRBORNE	15:06:16
MNB 508	APP	BLACK SEA FIVE ZERO EIGHT BRIZE APPROACH GOOD AFTERNOON IDENTIFIED TRAFFIC ONE O'CLOCK ONE MILE SIMILAR HEADING COORDINATED ONE THOUSAND FEET ABOVE	15:06:19
APP	MNB 508	OK, WE HAVE IT IN SIGHT	15:06:27
MNB 508	APP	BLACK SEA FIVE ZERO EIGHT REQUEST YOUR PASSING ALTITUDE?	15:06:48
APP	MNB 508	NOW ABOVE TWO THOUSAND NINE HUNDRED AND NOW SETTING THE STANDARD ALTIMETER	15:06:51
MNB 508	APP	BLACK SEA FIVE ZERO EIGHT YOUR CLIMB OUT RESTRICTION WAS TWO THOUSAND TWO HUNDRED FEET, AVOIDING ACTION STOP CLIMB IMMEDIATELY TURN RIGHT HEADING ZERO TWO ZERO DEGREES	15:06:58
APP	MNB 508	NOW ABOVE THREE THOUSAND FOUR HUNDRED, ER, RIGHT HEADING ZERO TWO ZERO CONFIRM?	15:07:04
APP	MNB 508	TCAS CALL SO WE ARE CLIMBING	15:07:11
MNB 508	APP	BLACK SEA FIVE ZERO EIGHT ROGER, CAN YOU SEE THE HELICOPTER IN YOUR ONE O'CLOCK BY HALF A MILE?	15:07:16
APP	MNB 508	YEAH WE HAVE IT IN SIGHT NOW CROSSING VISUALLY	15:07:20
MNB 508	APP	SEA FIVE ZERO EIGHT ROGER WITH THAT AIRCRAFT IN SIGHT CONTINUE CLIMB WHEN READY FLIGHT LEVEL EIGHT ZERO YOU'RE NOW ABOVE IT	15:07:23
APP	MNB 508	NOW NORMAL VECTOR, AND WE ARE STILL CLIMBING AND MAINTAINING HEADING TWO EIGHT ZERO	15:07:30
MNB 508	APP	BLACK SEA FIVE ZERO EIGHT	15:07:35

Table 2

RT exchange after takeoff

The A300 crew were visual with the Chinook soon after takeoff and received an expected TCAS Traffic Alert. When the TCAS RA activated, the commander followed the operator's Standard Operating Procedures (SOPs) and disconnected the autopilot (AP) and autothrust (AT). He then followed the green arc of the vertical speed scale, adjusting the thrust to maintain speed and avoiding the red arc of the vertical speed scale. When clear of the conflict, the A300 was cleared by ATC to continue to join controlled airspace five miles north of Malby and to resume its own navigation. The commander re-engaged the AP and AT and continued with the departure.

The A300 crew did not pass their SID, passing altitude or cleared altitude on initial contact with the approach controller and the controller did not request this information. The approach controller did request the aircraft's passing altitude some 32 seconds later, by which time the aircraft had passed through the 2,200 ft Climb-out Restriction and was coming into conflict with the Chinook. The returns of the A300 and the Chinook merged on the approach controller's radar display. Both aircraft tracks are shown at Figure 1.

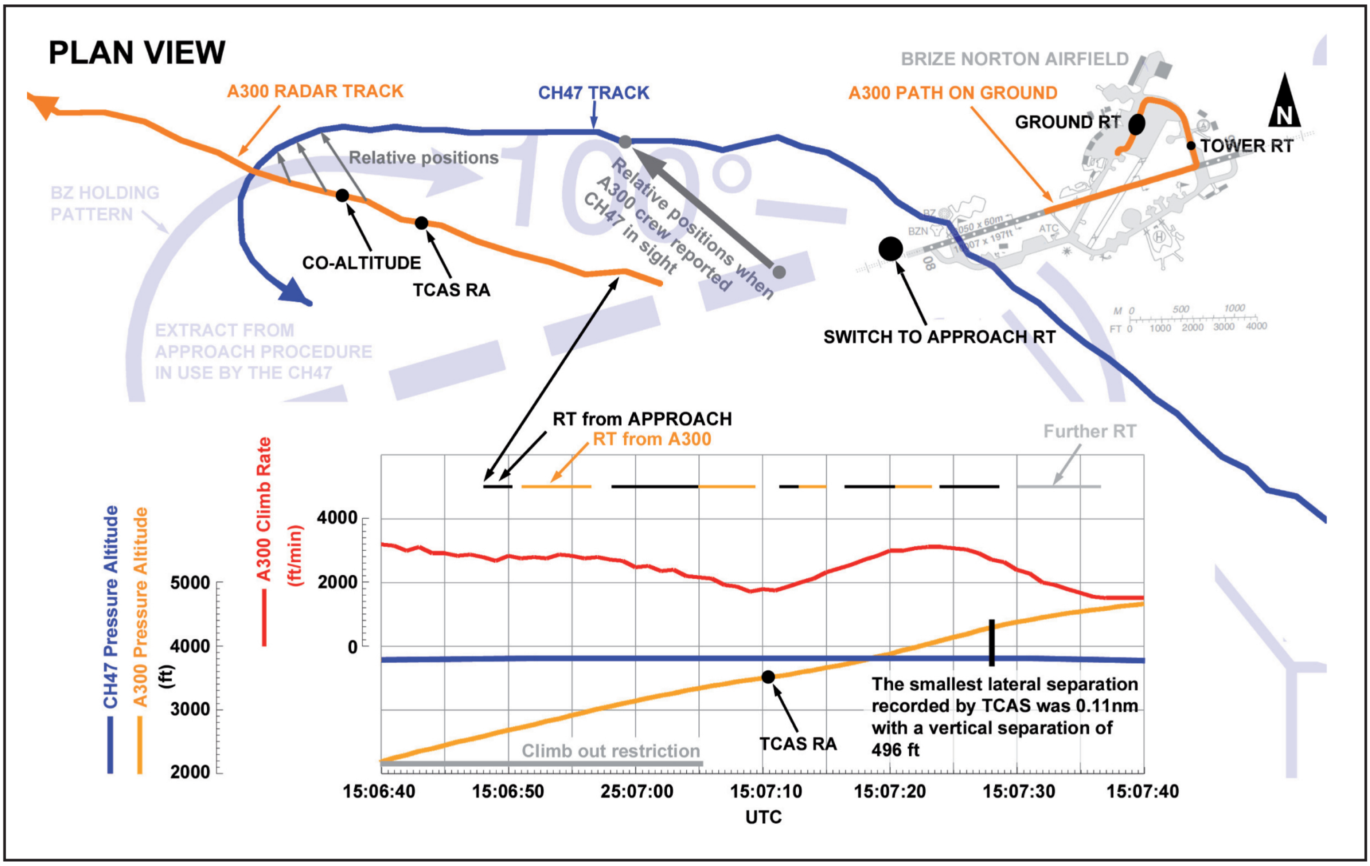

Figure 1

A300 and Chinook tracks

Radiotelephony

CAP 413, the 'Radiotelephony Manual', contains both the civilian and military RT terminology to be used when communicating on the radio. The term 'Climb-out Restriction' is not included in either the civilian or military sections. It does appear in other military documents but these are not available to civilian pilots.

CAP 413, Chapter 4, page 8, paragraph 1.7.10, states:

> *'Local departure instructions may be given prior to the take-off clearance. Such instructions are normally given to ensure separation between aircraft operating in the vicinity of the aerodrome.'*

It then gives an example of the phraseology to be used in relation to altitude restriction which is:

> *'Climb to altitude 6000 feet.'*

CAP 413 sets out the requirement for certain information to be included on initial contact with the controller during an instrument departure. The text is set out below:

> ***'1.4 Initial Call – IFR flights***
>
> ***1.4.1 Format of Initial Calls***
>
> *Pilots of aircraft flying Instrument Departures (including those outside controlled airspace) shall include the following information on initial contact with the first en-route ATS Unit.*

> *a) Callsign;*
>
> *b) SID or Standard Instrument Departure Route Designator (where appropriate);*
>
> *c) Current passing level;* ***PLUS***
>
> *d) Initial climb level (i.e. the first level at which the aircraft will level off unless otherwise cleared. For example, on a Standard Instrument Departure that involves a stepped climb profile, the initial climb level will be the first level specified in the profile.'*

The A300 crew's initial contact transmission after departure should have included the passing altitude and "climbing FL080". This would have immediately alerted the controller to the fact that the aircraft would not level at 2,200 ft.

Safety action

Following this incident, Brize Norton amended the BZN ATC Controllers Order Book (COB), Part 2 document, '*Responsibilities of the Radar Approach Controller*'. The reason for this change was that if a Climb-out Restriction had been imposed on a departure and the crew did not state their cleared altitude or level on initial contact with the approach controller, the controller would remind them of the Climb-out Restriction (COR) at the first opportunity. This was to prevent the aircraft exceeding its cleared altitude or level. The following text was added:

> *'On initial contact any COR must be repeated to the pilot unless the aircraft departs stating climbing to the appropriate level which complies with the COR passed. Traffic information should be passed ASAP on the unknown or co-ordinated traffic to improve situational awareness.'*

It was recognised that with high rates of climb, 3,000 ft/min in this incident, any delay in the crew changing to the approach frequency, or RT from other aircraft preventing communication, would not allow sufficient time for the climb to be stopped. This safety action was therefore modified to the following:

ATC to Aircraft: "*CALLSIGN* HOLD POSITION, NEW DEPARTURE INSTRUCTIONS WHEN READY TO COPY".

Aircraft to ATC: "READY TO COPY".

ATC to Aircraft: "*CALLSIGN* AFTER DEPARTURE CLIMB MALBY SID TO ALTITUDE 2800' BRIZE QNH READ BACK".

Brize Norton ATC has also ceased using the term 'Climb-out Restriction'.

Previous incident

On 1 December 2009, an Airprox incident occurred involving an RAF Lockheed TriStar in the BZ holding pattern and a commercial Boeing 767 (B767) departing from Runway 08. The B767 crew were passed the following ATC clearance:

> 'AFTER DEPARTURE, MAINTAIN RUNWAY TRACK CLIMBING 2,800 FEET QNH, FOR RADAR VECTORS TO JOIN CONTROLLED AIRSPACE 5 NM NORTH OF MALBY LEVEL FL 080. SQUAWK FREQUENCY FOR LONDON CONTROL 134.750 WHEN INSTRUCTED. FREQUENCY FOR BRIZE APPROACH 127.250'.

The controller's intention was for the B767 to stop the climb and level at 2,800 ft. This was misunderstood by the B767 crew who interpreted the clearance as a climb on runway track to 2,800 ft but that their cleared level was still FL 080.

The UK Airprox Board (UKAB) assessed the cause of the incident as the controller passing an ambiguous clearance to the B767 crew, which included both a local departure clearance and an airways clearance. The UKAB recommended that the MoD conduct a review of the CAP 413 instructions about the passing of Climb-out Restrictions. Following the review the MoD stated that it would emphasize the need not to overcomplicate clearances and that airways clearances should be clearly separated from zone/departure clearances.

Recorded information

The AAIB was notified of the incident too late for the A300 flight recorders to hold any relevant data. However, the military downloaded the flight data recorders from the Chinook on the day of the event and subsequently provided the relevant recordings to the AAIB to assist in the investigation. The audio recordings were all after the event but the flight data covered the period of interest. The A300 operator supplied flight data from the aircraft's Quick Access Recorder.

The A300 operator also downloaded the TCAS. This yielded a recording of the Resolution Advisories generated during the encounter, including relevant parameters associated with the Chinook, such as sensed distance and bearing and ATC transponder altitude.

Neither the radar returns from the Brize Norton radar, nor the Brize Norton controller displays are recorded[1]. However, the NATS[2] Clee Hill radar feed, used by Brize Norton ATC, was recorded and provided to the AAIB by NATS, along with radar data from Heathrow. Both Clee Hill and Heathrow sources included primary and secondary radar with additional Mode S parameters from the A300. The A300 Mode S recordings yielded downlinked parameters such as selected altitude and vertical speed. The Chinook ATC transponder, although Mode S capable, was selected to Mode C, degrading the resolution of the transmitted altitudes to 100 ft increments instead of 25 ft increments. The Heathrow data provided the best refresh rate and was used for assessing the relative lateral positions of the aircraft during the encounter.

The radio transmissions recorded at Brize Norton were made available to the AAIB.

The data and audio recordings were amalgamated and the relevant information is presented in the 'History of the flight' section of this report.

TCAS performance

NATS and the TCAS manufacturer assessed the encounter data and the effects of the A300 TCAS having to use the degraded Mode C 100 ft data instead of the Mode S 25 ft data. This data is used by TCAS to assess closing geometries, to select a strategy for resolving any conflict, and to issue appropriate Resolution Advisories. In this case, there was little effect on the TCAS resolution of the situation.

Analysis

TCAS performance – use of Mode C instead of Mode S

The Chinook ATC transponder was Mode S capable but was selected to Mode C. This downgraded the resolution of the altitude data it transmitted from 25 ft to 100 ft increments. In this case the altitude data resolution difference did not have a significant effect on TCAS performance. However, this may not be the case with different encounter geometries.

Footnote

[1] The CAA CAP 670 "*AIR TRAFFIC SERVICES SAFETY REQUIREMENTS*" requirement to record ATS surveillance data at civil airfields came into effect on 1 January 2012. This is not applicable to military airfields. Military capabilities in this regard are planned for the 2014-2020 time frame.

[2] NATS is the air traffic control service provider for UK airspace and the eastern part of the North Atlantic.

Whilst there is no requirement to use Mode S in the airspace the Chinook was being flown in at the time, given that changing to Mode S required only a switch selection, consideration should be given by the Chinook operation to using Mode S in preference to Mode C, to ensure the best available TCAS performance. The following Safety Recommendation is therefore made:

Safety Recommendation 2012-006

It is recommended that the Ministry of Defence review the practice of selecting Mode C on aircraft transponder equipment when Mode S, which allows enhanced TCAS performance, is available.

Operational matters

The sequence of events that led to the loss of separation was brought about by a combination of communication issues and misunderstanding. The initial clearance for the Malby SID was read back correctly and entered into the A300's Flight Management System (FMS) with the 8,000 ft step altitude selected as the target level.

The tower controller used the term 'Climb-out Restriction' in accordance with his Standard Operating Procedures (SOPs), to restrict the altitude to 2,200 ft. Both the commander and co-pilot of the A300 were familiar with this term, but because their focus was on the issue of runway length they misunderstood the altitude passed as being the runway length reduction when departing from holding point Echo.

When the co-pilot responded to the revised clearance he only read back the QNH. The controller asked him to confirm the Climb-out Restriction, but again, the co-pilot was focussed on runway length and simply responded "YES GOOD, COPIED THANK YOU". The controller then emphasised that "I NEED YOU TO SAY BACK, CLIMB OUT RESTRICTION 2,200 FEET". The co-pilot responded "YEAH, TWO THOUSAND TWO HUNDRED FEET COPIED", but was still focussed on the runway length. The controller, who was unaware of the crew's misunderstanding of the instruction, did not pursue the full read back of the 'CLIMB OUT RESTRICTION', which might have alerted the crew, and cleared the aircraft to line up and wait. In order to correct the crew's belief that the 2,200 ft related to runway length, he would have had to explain, in plain language, that the 2,200 ft was an altitude.

After takeoff, the crew contacted the approach controller but did not pass their SID, passing altitude and cleared level. Had they passed what they understood to be their cleared level of FL 080, it would have been immediately apparent to the approach controller that they were not complying with the 2,200 ft altitude restriction.

The A300 was squawking Mode S and, although Brize Norton receives Mode S data, it does not have the necessary equipment to display the information on the radar monitors and is therefore limited to displaying only Mode C information. Mode S displays more information than Mode C, included in which is the selected target altitude. Had this been displayed it might have alerted the approach controller to the incorrect setting of the target altitude.

The A300 crew were visual with the Chinook soon after takeoff and received an expected TCAS Traffic Alert. This changed to an RA, to which the commander, as the pilot handling, responded correctly. The co-pilot informed the approach controller as required.

If the term 'Climb-out Restriction' is to be used by military controllers it should be included in Section 10 of CAP 413. Having adopted CAP 413, the MoD controllers should not use that term, but should use instead the phraseology included in CAP 413: '*climb to* *altitude (allotted altitude) feet*'. The following Safety Recommendation is therefore made:

Safety Recommendation 2012-007

It is recommended that the Ministry of Defence ensure that standardised phraseology is used in accordance with the Civil Aviation Publication (CAP) 413: Radiotelephony Manual.

Conclusions

The Airprox occurred due to the misunderstanding by the A300 crew of the meaning of the ATC instruction 'CLIMB OUT RESTRICTION TWO THOUSAND TWO HUNDRED FEET', which they took to mean the runway length reduction when making an intersection departure from holding point Echo. They therefore did not change their selected target altitude from 8,000 ft to the required 2,200 ft. Contributory factors were that this phrase was not standard RT phraseology and the A300 crew omitted to provide their departure information on initial contact with the approach controller.

SERIOUS INCIDENT

Aircraft Type and Registration:	ATR72-202, EI-SLG
No & Type of Engines:	2 x Pratt and Whitney PW124B turboprop engines
Year of Manufacture:	1990
Date & Time (UTC):	15 March 2011 at 2130 hrs
Location:	Near Edinburgh Airport
Type of Flight:	Commercial Air Transport (Non-Revenue)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	4,092 hours (of which 3,500 were on type) Last 90 days - 72 hours Last 28 days - 29 hours
Information Source:	AAIB Field Investigation

Synopsis

On the first flight following a maintenance check, the aircraft experienced an uncommanded yaw resulting in a roll to the left as it accelerated through 185 kt. Directional control was regained and subsequent cockpit indications identified a fault with the rudder Travel Limitation Unit (TLU). The aircraft returned to Edinburgh Airport, where it landed safely. The investigation into this serious incident was conducted in conjunction with the Air Accident Investigation Unit (AAIU) of Ireland and the 'Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile' (BEA) of France. The investigation established that a cam on the rudder TLU mechanism had been removed and incorrectly refitted during the maintenance check. As a result of this incident AAIB Special Bulletin S1/2011, containing three Safety Recommendations, was published on 15 April 2011. Since this incident the aircraft manufacturer and the engineering organisation have taken safety actions to minimise the possibility of a similar event recurring. Two further Safety Recommendations are made in this final report.

History of the flight

The aircraft had undergone routine maintenance at an engineering facility at Edinburgh Airport immediately prior to the incident flight. The crew were due to position the aircraft to Paris on the afternoon of the incident, departing at 1600 hrs. However, on arrival they were informed that the aircraft would not be ready until 1830 hrs due to outstanding work required. They returned at 1830 hrs to be informed that it was still not ready, but they proceeded to the aircraft nevertheless to commence their preparation, expecting only a short delay. In accordance with company procedures, the co-pilot carried out the internal cockpit preparation whilst the commander carried out the external inspection. With the exception of two minor issues in the cockpit that were quickly resolved, the preparation proceeded normally and the aircraft was ready for operation by 2057 hrs.

The crew completed the pre-flight checks, all of which appeared normal. These included, as part of the 'Before Takeoff' checks, a check of the flying controls for full and free movement, during which the crew were able to monitor the roll control surfaces visually and observe the spoiler operation on a cockpit indication. The crew could not see the empennage and the aircraft was not fitted with a control position indicator.

The aircraft took off from Runway 24 at 2122 hrs with the co-pilot acting as the handling pilot. It was dark, with a reported broken cloud base at 1,700 ft and a light, westerly surface wind. After carrying out a standard instrument departure, the crew climbed the aircraft to FL230 at an airspeed of 170 kt with the autopilot engaged. As the aircraft levelled and accelerated through about 185 kt, the crew felt it roll to the left by about 5° to 10° and they noticed that the slip ball was indicating fully right. The co-pilot disengaged the autopilot and applied right rudder in an attempt to correct the sideslip, and right aileron to correct the roll. He reported that the rudder pedals felt unusually "spongy" and that the aircraft did not respond to his rudder inputs. He had to maintain 15° to 20° of right bank to hold a constant heading with the speed stabilised above 185 kt and applied a small amount of aileron trim to assist. The co-pilot commented that he was reluctant to use more aileron trim due to the varying amount of bank required. Shortly after regaining directional control a FLT CTL caption appeared on the Crew Alert Panel (CAP) and a FLT CTL fault light illuminated on the overhead panel, indicating a fault with the rudder TLU. In light of the control problems the commander requested radar vectors from ATC for a return to Edinburgh, later declaring a PAN. The co-pilot assessed that he had very little control authority to make right turns, so the commander requested that only left turns be given.

Having commenced a return to Edinburgh, the crew carried out the required QRH procedure (Figure 1). In following the procedure they established that both Air Data Computers (ADC) were operating before setting the TLU switch to the LO SPD position, believing that the aircraft had by then slowed below 180 kt. The co-pilot reported that on LO SPD being selected additional roll control input was required to hold the bank angle and that roll authority to the right was further reduced. The commander therefore decided to return the TLU switch to AUTO and the required roll control input reduced. The

TLU FAULT

- **If ADC 1 + 2 are lost**
  - **If IAS above 185 kt**
    TLU .... HI SPD
  - **If IAS below 185 kt**
    TLU .... LO SPD
  DISREGARD TLU FAULT ALERT
- **If at least one ADC operates**
  - **If IAS above 185 kt**
    TLU .... HI SPD
    - **If TLU FAULT alarm persists**
      SPEED .... 180 KT MAX
      TLU .... LO SPD
  - **If IAS below 185 kt**
    SPEED .... 180 KT MAX
    TLU .... LO SPD
    DISREGARD TLU FAULT ALERT
    - **If TLU green light is not lit**
      VAPP .... INCREASE BY 10 KT
      LDG DIST .... MULTIPLY BY 1.13
      LAND AT AIRPORT WITH MINIMUM CROSSWIND

Note: Maximum demonstrated crosswind (dry runway) with TLU HI SPD mode : 15 kt.

Figure 1

ATR 72 QRH Section 2.22 A - TLU Fault

green LO SPD light did not illuminate and the crew added 10 kt to their approach speed, in accordance with the QRH.

The co-pilot was able to position the aircraft as directed by ATC, descending at a speed of approximately 180 kt, with a rate of descent of between 1,000 and 1,500 ft/min. The weather for the flight remained good, with a surface wind of 250° at 5 kt and the aircraft remained in VMC throughout the approach. It was established on the ILS for Runway 24 and configured for a full flap landing. The rudder trim, which appeared to be inoperative, was also centred. The co-pilot required both hands on the flight controls in order to maintain directional control and so the commander operated the power levers late on the final approach. The co-pilot reported that although the aircraft became slightly more difficult to control as the speed reduced, it remained controllable.

The aircraft touched down at 2203 hrs just to the left of the runway centreline and the commander took control, applying reverse thrust. The aircraft had landed right main wheel first and during the subsequent rollout, despite applying full right rudder pedal, it diverged towards the left edge of the runway. The commander was finally able to establish directional control using the steering wheel tiller and the aircraft was slowed to taxi speed. The commander was then able to taxi the aircraft clear of the runway and back to the engineering facility for inspection, the aircraft responding normally to steering commands.

Maintenance inspections following the incident

The maintenance organisation examined the aircraft on the morning after the incident to determine the cause of the uncommanded roll and FLT CTL fault reported by the flight crew. An operational test of the TLU was performed during which an asymmetric rudder pedal restriction was noted when the TLU moved towards the reduced authority position[1]. A subsequent visual inspection of the TLU confirmed that one of the cams on the rudder rear quadrant shaft had been incorrectly installed, such that it was misaligned with the other cam. The maintenance organisation immediately commenced a maintenance error investigation, suspending the approvals of the engineers concerned.

Flight Recorders

The aircraft was fitted with a 25-hour magnetic tape Flight Data Recorder (FDR) and 30-minute magnetic tape Cockpit Voice Recorder (CVR). These were removed from the aircraft following the incident for the data to be downloaded and analysed by the AAIB. The 30-minute duration of the CVR meant that the voice recording during the initial stages of the incident was overwritten with later recordings. Also, the FDR recording was of such poor quality that the data was unreliable and therefore unusable. However, the aircraft was also fitted with a Quick Access Recorder (QAR) that had recorded the same flight data. A copy of the QAR data was obtained by the AAIB.

A history of salient (and available) parameters from the QAR for the incident flight is shown in Figure 2. Highlighted (in pink) is the portion of the flight during which the aircraft had accelerated through 185 kt (2126:25 hrs) and then decelerated to below 180 kt (2141:54 hrs). In normal operation, during this period, the TLU would have been in the reduced authority position.

As the aircraft accelerated through 185 kt, the rudder position moved to 2° left (ie aircraft nose-left) at a

Footnote

[1] In the reduced authority (or high speed) position, rudder deflection is mechanically limited by the TLU. In the full authority (or low speed) position, rudder deflection is not limited.

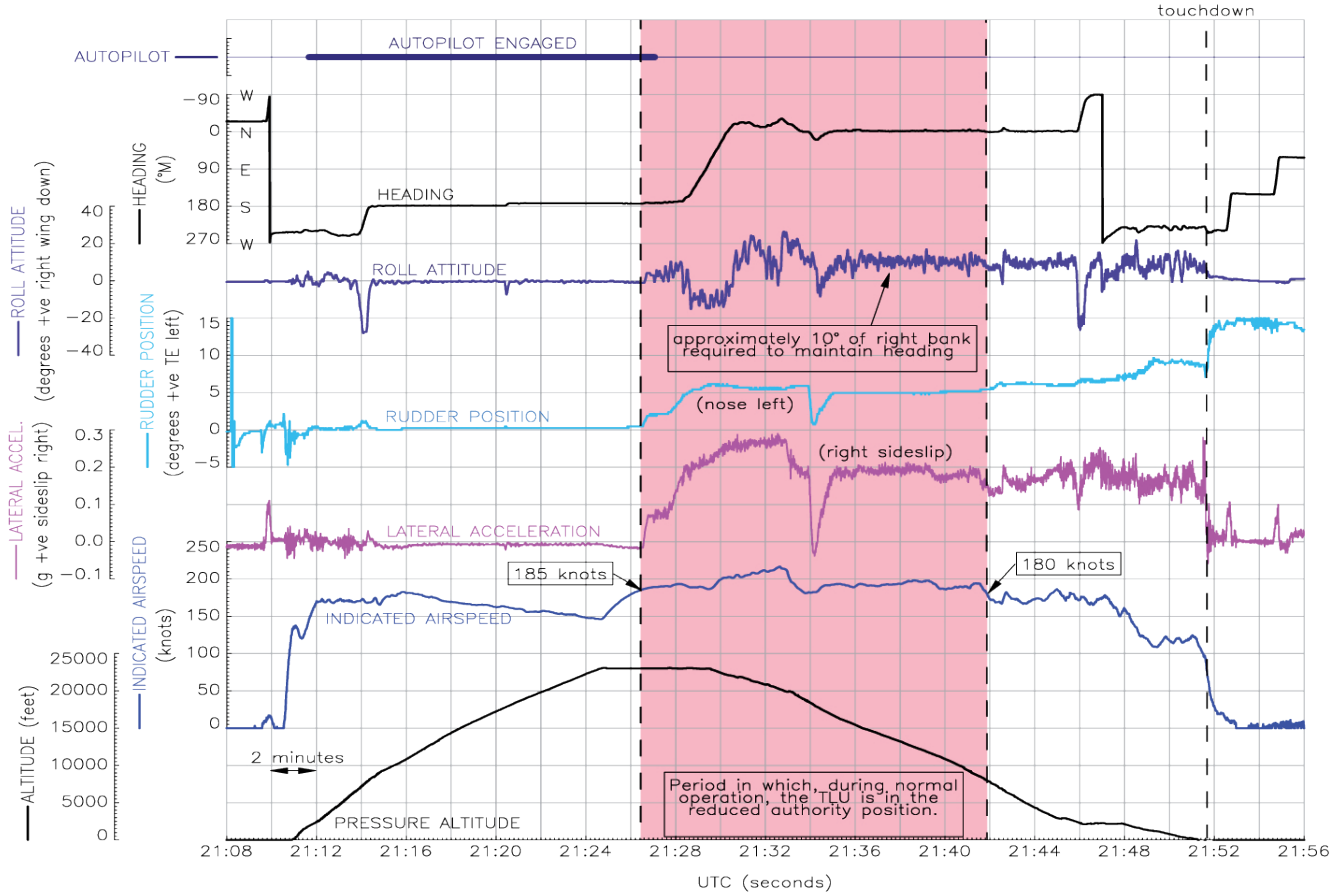

Figure 2

Salient QAR parameters

constant rate of 0.12°/s causing the aircraft to sideslip to the right. The autopilot then rolled the aircraft 4° right-wing-down to maintain the heading. The autopilot was disengaged shortly thereafter.

Over the next two minutes the rudder deflected further to the left (to 6°), during which time the aircraft was turned through 180° for a return to Edinburgh. At 2134 hrs, the rudder deflection decreased rapidly to below 1° left (0.55°/s) following a reduction in airspeed to 180.75 kt[2], before deflecting back to 5° (at 0.07°/s). The rudder remained in this position, with approximately 10° of right bank required to maintain heading, until the aircraft airspeed decreased to below 180 kt, seven minutes later (2141:54 hrs). At this point the rudder gradually deflected further to the left, reaching 8° at touchdown. Coincident with the touchdown, rudder deflection increased up to 15° left, where it remained until the end of the QAR recording.

An inspection of the FDR installation found that the rubber mounts, designed to isolate the FDR from excessive vibration to maintain a good contact between the record head and the magnetic tape media, were degraded and in need of replacement. The operator reported that there were no specific inspection requirements for these mounts in the aircraft manufacturer's maintenance programme. As a result,

Footnote

[2] The sample rate for the indicated airspeed was 1 sample per second with a resolution of 0.25 kt.

they introduced a specific two-yearly inspection task on their ATR fleet to check the integrity of the FDR mounts.

Rudder travel limitation unit

The rudder linkage on the ATR 72 is a mechanical system composed of quadrants, pulleys, rods and cables. The TLU, installed on the rudder rear quadrant shaft (Figure 3), reduces the range of available rudder deflection at airspeeds above 185 kt, in order to limit the structural loads on the rudder. In the full authority (or low speed) position, rudder deflection is not limited; in the reduced authority (or high speed) position, rudder deflection is mechanically limited by the TLU.

The TLU mechanism comprises an electrical actuator which drives a pivoting bracket on which two rollers are mounted (Figure 4). In the reduced authority position the actuator retracts, engaging the rollers in two v-shaped cams mounted on the rudder rear quadrant shaft, to limit the rudder deflection mechanically. In the full authority position the actuator extends, disengaging the rollers from the cams and rudder deflection is no longer limited. A green LO SPD indicator light illuminates in the cockpit centre console when the TLU is in the full authority position.

The TLU is controlled by a guarded three-position (HI SPD/AUTO/LO SPD) selector switch on the overhead panel. In normal operation the switch is in AUTO. The actuator automatically retracts when both ADCs signal that the airspeed is greater than 185 kt and automatically extends when at least one ADC signals that the airspeed is less than 180 kt. The actuator stroke duration in automatic mode is approximately 15 seconds.

The TLU actuator position is monitored by the Multifunction Computers (MFC) and compared with the airspeed signal from the ADCs. In the case of a disagreement, the FLT CTL fault light on overhead panel and FLT CTL caption on the Crew Alert Panel (CAP) will illuminate; the master caution light and single aural chime are also triggered.

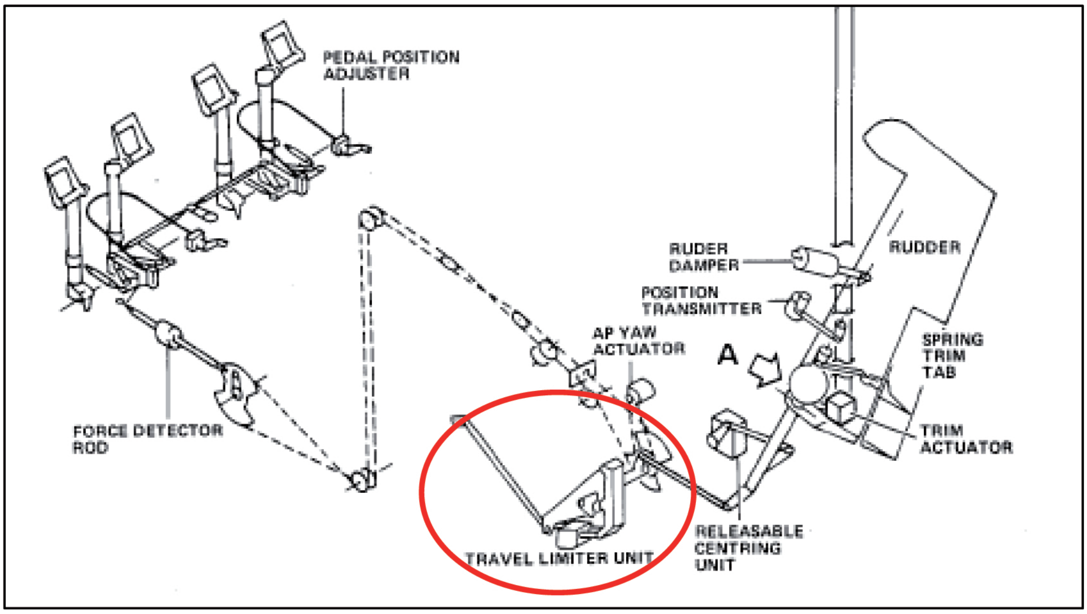

Figure 3

ATR 72 Rudder control system

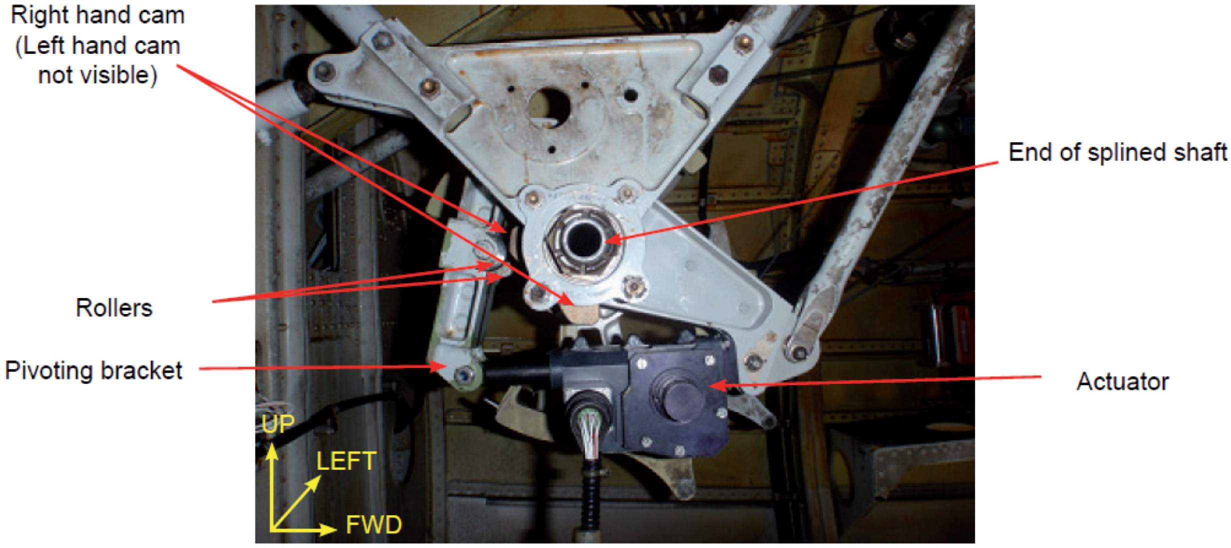

Figure 4

Rudder Travel Limitation Unit

In the case of a FLT CTL fault the actuator extension and retraction may be manually selected by setting the selector switch to HI SPD or LO SPD, according to the aircraft speed. The duration of the actuator stroke in manual mode is approximately 30 seconds.

Maintenance history

Between 19 February 2011 and 15 March 2011 the aircraft had undergone a planned '2-year'[3] maintenance check at a Part 145 approved maintenance organisation in Edinburgh. During the check it was determined the TLU actuator had to be replaced due to excessive moisture indications in the actuator desiccant cartridge. This was completed on 7 March 2011 and, as required in the Aircraft Maintenance Manual (AMM) task, an operational test of the TLU was performed. This work was certified by a licensed aircraft engineer (LAE), who will be referred to as 'Cert A'. As the actuator replacement involved disturbance of a flight control system, independent (duplicate) inspections of the installation and the operational test were required; this was carried out on 9 March 2011. The first part of the independent inspection was performed by Cert A, and the second by the check leader.

While conducting a final check of the area for any loose items following completion of the independent inspections, Cert A observed that the rudder cables seemed very tight and he raised a Non Routine Job Card (NRC) for the cable tensions to be checked. He also noted some play in the bearing of the TLU support arm. As this defect was discovered at a late stage in the check, Cert A discussed his findings with the check leader who referred him to the production manager. The production manager advised Cert A to remove the TLU support arm for closer examination. Cert A referred to AMM job card 27-23-30 RAI 10000-001 *'Removal and Installation of TLU Mechanism Assembly'* which involved relaxing the rudder control cables, removing the TLU actuator and partially disassembling the rudder rear quadrant shaft. It was the first time he had performed this task.

Footnote

[3] A '2-year' check is a heavy base maintenance check that can take two to three weeks to complete.

Upon examination of the TLU support arm, Cert A and the production manager concluded that the bearing housing was showing signs of wear which was allowing the bearing to migrate. However they considered the wear to be minor and unlikely to prevent the bearing from functioning correctly. As the aircraft was due to leave the hangar in four days, the production manager considered that there would be little chance of obtaining a replacement part without delaying the aircraft, but he did not perform a stock check to verify this. Instead, he advised Cert A to reinstall the TLU support arm and suggested the fitting should be 'peened' to prevent further movement of the bearing.

Both considered that peening (using a centre-punch to create a small lip at a number of locations around the edge of the bearing housing) was a standard engineering practice to retain loose bearings. They did not consult the ATR 72 Structural Repair Manual (SRM) or AMM to determine if this practice was an approved repair on the TLU support arm. Neither document contains reference to such a repair. Cert A asked the production manager if an NRC should be raised to document the defect and the subsequent rectification, but the production manager decided to proceed without raising the appropriate repair documentation.

Cert A reassembled the TLU mechanism on the following day. He was deputising for the check leader and was the only certifying engineer working on EI-SLG that day. With the aircraft due to leave the hangar in three days, he was interrupted from the reassembly task numerous times to perform check leader functions. Having initially installed the TLU support arm, spacers and the left cam on the rudder rear quadrant shaft and checked that both cams were correctly aligned, Cert A was unsure of the order in which two of the spacers should be fitted, as this was not very clear in the AMM diagram. He removed the spacers and laid them out to compare them with the AMM diagram. The right cam also came off and he inadvertently placed it back on the shaft in the incorrect orientation. Cert A reported that the cam slid easily onto the shaft and he was confident that it was correctly aligned because he believed that the master locating spline on the rudder rear quadrant shaft was specifically intended to prevent misalignment of the cams. Once satisfied with the order in which the components had to be fitted, he completed the reassembly of the TLU mechanism up to the point where the next step was the rigging and tensioning of the rudder cables, for which he had previously raised a separate NRC. Following this step, the AMM task also required a functional test of the rudder control, an operational test of the rudder control and spring tab and an operational test of the TLU to be performed. As no job card had been raised for the repair, Cert A made a mental note to perform an operational test of the TLU at a later stage but he omitted to do this. None of the required functional checks on the TLU were performed. Cert A performed check leader functions for the remainder of the day. No further work was carried out on the TLU during the remainder of the check. The NRC raised for rigging and tensioning the rudder cables was completed and signed off on 13 March 2011 by the opposite shift and did not require any disturbance of the TLU system.

Organisational information

General

The maintenance organisation had previously been owned by the aircraft operator but both were now sister companies and part of a larger group. Two of the operator's aircraft had recently experienced significant delays at the Edinburgh facility, a situation which had caused frustration within the maintenance organisation, the operator and at group level. Another of the operator's aircraft was planned in for maintenance immediately following EI-SLG. The management at the maintenance organisation considered that another delayed aircraft would have been viewed as a major failure on their part and would result in loss of revenue if the following aircraft could not be accommodated. The production manager stated that these factors directly influenced his decision not to delay the EI-SLG check by ordering a replacement TLU support arm and not to record the work carried out on this system.

Management of maintenance inputs

A check leader was assigned to manage each aircraft maintenance check. This role involved allocation of job cards and manpower, ordering of spares and reporting on the progress of the check. A number of mechanics and LAEs were assigned to each aircraft, and the senior LAE would deputise for the check leader in his absence.

Working hours

The shift patterns for the engineers were 4 days on followed by 4 days off, working 12 hours per day from 0700 to 1900 hrs. On the day the TLU cam was incorrectly installed, Cert A was working his fifth twelve-hour day in a row. He did not consider that he felt physically tired. However, he stated that he may have been mentally fatigued as a result of the heavy workload, the time pressure towards the end of the check and the additional stress of deputising for the check leader.

Material supply to maintenance checks

This operator had a policy of directly purchasing parts from the aircraft manufacturer, and forwarding them to the maintenance organisation. The maintenance organisation considered that this practice would often result in delays, causing a backlog of work towards the end of the maintenance check.

Maintenance personnel

Cert A had worked for the organisation for 3½ years, initially as a technician before undertaking his licence exams. He was awarded a 'B1' category licence in November 2009 and an ATR 72 type rating and company approvals in May 2010. Despite being recently licensed, he was considered within the organisation to be a very capable engineer, frequently assisting the check leader and often deputising in this role.

The production manager was an experienced engineer who had worked for the organisation for two years. He was a 'C1' category LAE, and held a type rating for the ATR 72. In this time he had been promoted to the role of check leader and was subsequently appointed as production manager, responsible for the overall management of the maintenance facility. This post also entailed acting as the Accountable Manager for the company's Part 145 maintenance organisation approval. In addition to this he also held the post of line maintenance manager.

The responsibilities of the Accountable Manager are stipulated in the maintenance organisation's Maintenance Organisation Exposition (MOE) and these include: ensuring that maintenance carried out meets the standards required by EASA and the UK CAA; establishing and promoting the safety and quality policy; enforcing any rectification that may be required to eliminate non-conformance; and ensuring compliance with the procedures contained in the company's MOE and Maintenance Procedures Manual.

Repair procedures

The procedures for standard repairs on the ATR 72 are contained in the aircraft manufacturer's Structural Repair Manual (SRM). If no standard repair exists, the maintenance organisation's technical services department must contact the aircraft manufacturer to obtain a repair scheme. The production manager stated after the incident that he should not have become involved in the decision about the repair to the TLU support arm and should have instead referred Cert A to technical services.

Independent inspections

In accordance with applicable regulations, when work is performed on safety critical systems (flight controls, engine controls, etc) an independent (duplicate) inspection must be performed. This requirement was reflected in the maintenance organisation's MOE.

Maintenance documentation

AMM job card 27-23-30 RAI 10000-001 *'Removal and Installation of the TLU Mechanism Assembly'* did not include any specific instructions regarding the orientation of the cams or include any warnings about the possibility of incorrect installation. However it did specifically state that only the right hand cam should be removed. This task required functional tests of the rudder and an operational test of the TLU following reassembly.

AMM job card 27-23-00 OPT 10000 *'Operational Test of the Rudder TLU'* checks that rudder pedal travel is not limited when the TLU is in the full authority position and that it is limited when the TLU is in the reduced authority position. It also checks that the TLU responds correctly to the speed signals from each ADC. A test switch in the cockpit can be selected to send a high speed signal to the TLU actuator during ground testing. When a Press-To-Test (PTT) button is depressed the TLU actuator retracts to the reduced authority position. Rudder deflection and rudder pedal travel are limited accordingly.

Post-incident testing

Incorrect installation of the TLU cam

The rudder rear quadrant shaft has a master locating spline which is intended to prevent rotational misalignment between the two TLU cams. Testing demonstrated that if a cam was removed and transposed through 180° (such that the inboard face of the cam then faced outboard) it could be installed without encountering any resistance, resulting in misalignment between the two cams (Figure 5). This is because the master spline is not located centrally between the two lobes on each cam, but is offset to one side. There are no markings on the cams to indicate their correct orientation.

Although the misalignment of the cams is evident in Figure 5, this is a side-on view of the TLU. Figure 6 is representative of the view that Cert A would have had when reassembling the TLU mechanism. The cam lobes are not visible from this perspective, and although evident, the misalignment between the two cams is more difficult to detect.

Effect of misaligned cam

With the right cam incorrectly installed, it was demonstrated that when the TLU was actuated towards the reduced authority position, both rollers were prevented from engaging in the cams. Instead, the right roller was observed to push upwards on the upper lobe of the right cam, causing the rudder rear quadrant shaft to rotate, deflecting the rudder surface and pedals. The maximum rudder deflection produced during testing on the ground (in the absence of flight loads) was 21°.

A condition could be produced where the right roller was pushing up against the upper lobe of the right cam and the left roller was pushing down against the lower lobe of the left cam, effectively creating a condition

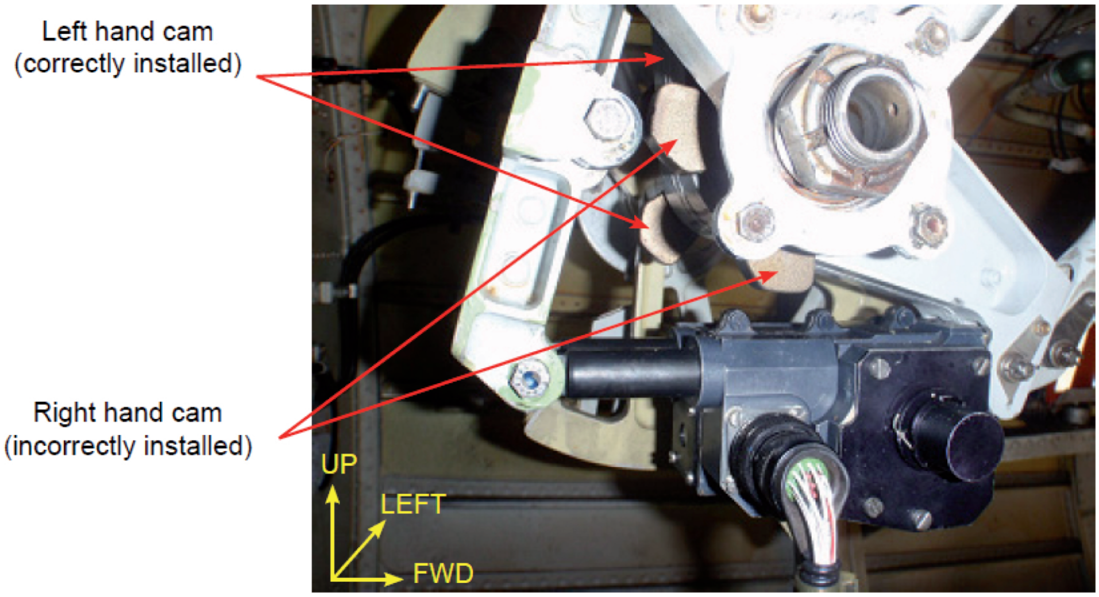

Figure 5

TLU with right cam incorrectly installed

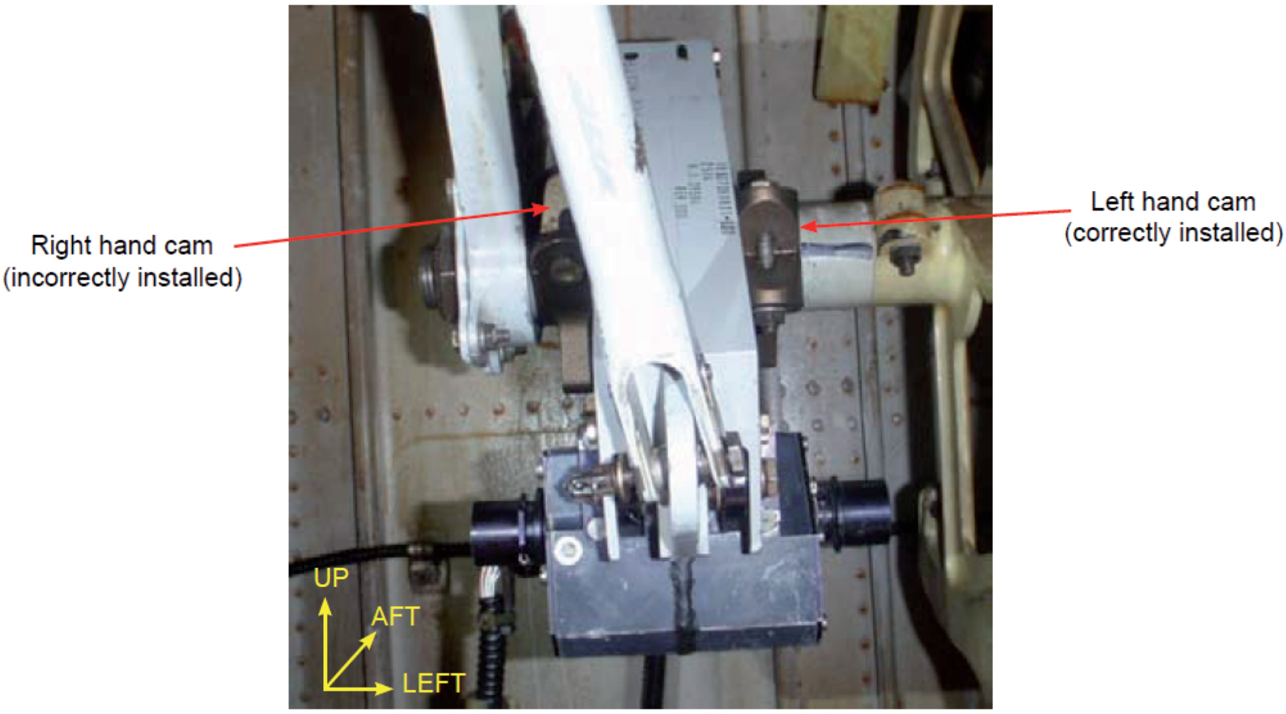

Figure 6

View looking aft on TLU – right cam incorrectly installed where the rudder surface and pedals were jammed in the deflected position (Figure 7).

TLU operational test

The AMM operational test was performed with the right cam incorrectly installed. During the test rudder pedal travel was found to be restricted in an asymmetric sense. A FLT CTL fault light illuminated, correctly indicating the disagreement between the aircraft speed configuration and actuator position, but only when the test button was depressed for a minimum of 25 seconds. The AMM task did not state how long the test button should be depressed.

Actuator testing

The TLU actuator was tested at the manufacturer's facilities to determine if there were any anomalies which may have contributed to the uncommanded rudder deflection; none were noted.

Analysis

Incorrect installation of the TLU cam

Inadequate staffing levels on the day of the maintenance error led to a situation in which a recently licensed engineer was working as the only certifying engineer on the aircraft and deputising for the check leader in a high workload environment. The associated distractions, time pressure and the possibility of fatigue are likely to have been detrimental to his focus on the task of reassembling the TLU. Tasks involving reassembly of components are more vulnerable to error than disassembly tasks as they require a greater reliance on memory and attention to the task.

The design of the TLU made it possible for the cam to be installed incorrectly. However the AMM contained no specific reference to the orientation of the cams and there were no markings on the cam to identify the correct orientation. The following Safety Recommendation is therefore made:

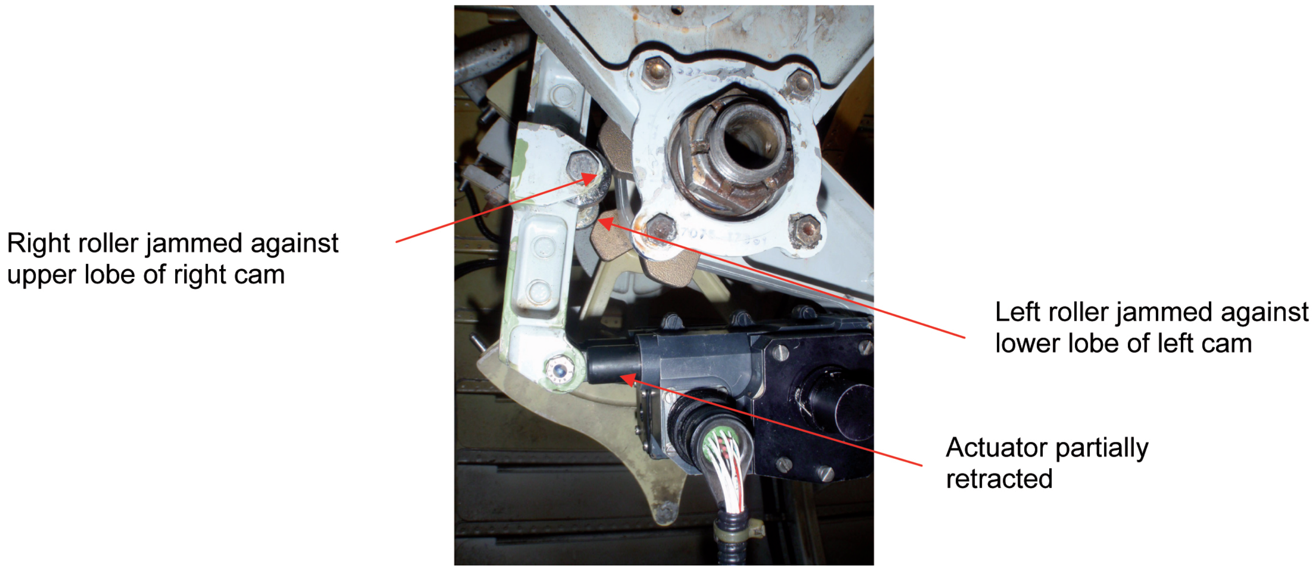

Figure 7

TLU partially retracted – rollers jammed against cams

Safety Recommendation 2012-002

It is recommended that the European Aviation Safety Agency require ATR to modify the cams on the rudder Travel Limitation Unit on all applicable aircraft, to reduce the risk of incorrect assembly.

Failure to detect the incorrectly installed cam

If an NRC had been raised to document the defect with the TLU support arm, the requirements for an operational test and an independent inspection of the TLU would have been raised. The decision not to record this maintenance resulted in these protections being removed and the maintenance error remaining undetected.

It was considered imperative by the management at the maintenance organisation that EI-SLG's check was completed on time. The relationship between the maintenance organisation and the operator, the associated time pressure, and the potential financial implications were all influencing factors in the production manager's decision to instruct the unapproved and unrecorded repair to be carried out on the TLU. This situation represented a conflict of interest between the production manager's commercial priorities and his obligations as the Accountable Manager. Further, these decisions were not challenged by Cert A.

Unapproved repair

Although the repair on the TLU support arm prompted the disassembly and reassembly of the TLU, the repair itself was not relevant to the operation of the TLU during the incident flight. The decision to proceed with this repair demonstrated non-adherence to both the aircraft manufacturer's and maintenance organisation's procedures.

Effect of incorrect cam installation on TLU operation

The misalignment of the two cams prevented the TLU rollers from engaging normally when the TLU was automatically actuated towards the reduced authority (high speed) position. The interaction between the rollers and cams instead caused the rudder rear quadrant shaft to rotate, resulting in a deflection of the rudder and rudder pedals. A review of the flight data shows the rudder deflection increased from 0° to 6° left as the aircraft accelerated through 185 kt. While actioning the QRH checklist the crew manually selected the TLU selector switch to the LO SPD position. They believed this action to be ineffective as the co-pilot perceived greater roll inputs were required to control the aircraft and the green LO SPD light did not illuminate. However, from the flight data the rudder deflection is observed to reduce rapidly towards 0° in response to this selection. Selecting the TLU switch to LO SPD places the TLU in manual mode, in which the actuator stroke takes 30 seconds. It is therefore likely that the TLU switch remained in the LO SPD position for less than the 30 seconds required to illuminate the green LO SPD light. Had the TLU switch remained in the LO SPD position, the rudder control restriction would have disappeared as the actuator reached the fully extended position, and the return to Edinburgh could have been completed without any further rudder control restrictions.

Having reduced the airspeed below 185 kt, the corresponding action in the QRH checklist did not contain any requirement for the TLU switch to be returned to the AUTO position. Neither did it contain reference to the fact that the green LO SPEED light would take up to 30 seconds to illuminate. The following Safety Recommendation is therefore made:

Safety Recommendation 2012-003

It is recommended that ATR amend the ATR 72 QRH section 2.22 A to state that the green LO SPD light should illuminate after 30 seconds, when the rudder Travel Limitation Unit switch is manually selected to the LO SPD position.

Returning the switch to the AUTO position caused the rudder deflection to increase to 5° left. As the airspeed subsequently reduced to below 180 kt the TLU actuator would have been expected to extend automatically, removing the control restriction; however instead, the rudder deflection began to increase gradually, reaching 8° left at touchdown. One scenario to explain this is that the TLU rollers became jammed between the two cams, such as occurred during ground testing, and the TLU actuator could not overcome the resistance. Another scenario is that the crew inadvertently placed the TLU switch in the HI SPD position rather than the AUTO position as reported. Subsequent testing of the actuator revealed no anomalies, so it was not possible to draw any firm conclusions on the actuator behaviour.

As only the resultant rudder surface deflection was recorded by the QAR, it was not possible to determine whether any rudder pedal inputs made by the crew throughout the event influenced the amount of rudder deflection.

Operational issues

The rudder control restriction would not have been evident to the flight crew during either the aircraft walkround checks or the pre-flight control checks and the first indication occurred as the aircraft accelerated through 185 kt.

The commander's decision to request ATC to give all turns to the left was based on the limited remaining control authority to the right, as significant right control inputs were required to maintain directional control. However in turning in the direction of the uncommanded roll they faced the possibility that there may have been insufficient control authority remaining to arrest the manoeuvre and avoid an uncontrolled roll departure to the left. Therefore, despite the limited control authority to the right, it may have been more prudent to have made all turns to the right.

The decisions made by the flight crew were based on the limited information they had available at the time while facing a problem of unknown origin which they were unable to resolve, and a desire to land the aircraft as soon as possible.

Safety actions

Aircraft manufacturer

The AAIB made the following Safety Recommendations to ATR in Special Bulletin S1/2011:

Safety Recommendation 2011-10

It is recommended that ATR immediately informs all operators of ATR aircraft equipped with a Travel Limitation Unit that it is possible to install the cams on the rear rudder quadrant shaft in the incorrect orientation.

Safety Recommendation 2011-11

It is recommended that ATR amends all relevant Aircraft Maintenance Manual tasks to include a warning to highlight that the cams on the rear rudder quadrant shaft can be installed incorrectly.

Safety Recommendation 2011-12

It is recommended that ATR amends the Aircraft Maintenance Manual task *'Operational Test of the Rudder Travel Limitation Unit'* to state that: (1) the test should be carried out for a minimum of 30 seconds and (2) should an asymmetric restriction of the rudder pedals be detected or if the FLT CTL light illuminates, further inspection of the TLU system should be conducted.

In response to these Safety Recommendations, ATR issued an All Operators Message (AOM) on 19 April 2011, to advise operators of this incident and to emphasise the importance of performing an independent inspection after any maintenance is performed on a flight control system. ATR have also updated the AMM task *'Removal and Installation of TLU Mechanism Assy'* to include a requirement to record the position of the right hand cam before removal. In addition, the AMM task *'Operational Test of the Rudder Travel Limiter Unit'* has also been amended to reflect the intent of Safety Recommendation 2011-12.

Maintenance organisation

A new Accountable Manager was appointed with immediate effect following the incident. As a result of their maintenance error investigation, the maintenance organisation identified a requirement for additional training of the two engineers involved, prior to reinstatement of their company approvals. Both engineers have since undertaken training courses on 'Aviation Legislation' and 'Human Factors' delivered by a Part 147 approved training organisation. The details of this incident have also been incorporated in the syllabus of the maintenance organisation's annual recurrent Human Factors training course.

As a result of the issues identified with the lack of adequate staffing cover of certifying engineers, the maintenance organisation has implemented a change in shift patterns. The hangar now operates a Monday to Friday operation, with two shifts: 0700 to 1600 hrs and 1000 hrs to 1900 hrs, in order to ensure there are more certifying engineers available during peak hours. In addition, a minimum of two certifying engineers are assigned to each aircraft in addition to the check leader. Where a certifying engineer deputises for the check leader, handovers are completed in writing and the production manager will step into the role of check leader if the number of certifying engineers on the check is compromised.

Conclusion

The incident was caused by the incorrect fitment of a cam on the rudder TLU mechanism which was not detected by maintenance personnel. This resulted in rudder control restriction which caused the aircraft to enter an uncommanded roll to the left when the airspeed increased above 185 kt. The required independent inspection of the work and the operational test of the TLU system were not carried out. Commercial pressure was identified as the most significant factor which influenced the decision to perform unapproved and unrecorded maintenance on the TLU system. A contributory factor was the design of the TLU cams, which allowed them to be installed in the incorrect orientation.

AAIB correspondence reports

These are reports on accidents and incidents which were not subject to a Field Investigation.

They are wholly, or largely, based on information provided by the aircraft commander in an Aircraft Accident Report Form (AARF) and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 747-4B5F, HL-7601
No & Type of Engines:	4 Pratt & Whitney PW4056 turbofan engines
Year of Manufacture:	2004 (Serial no: 33946/1350)
Date & Time (UTC):	17 January 2012 at 1630 hrs
Location:	Over the Irish Sea
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 3 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	16,231 hours (of which 7,312 were on type) Last 90 days - 197 hours Last 28 days - 65 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

HL-7601 was operating a Commercial Air Transport (Cargo) flight from Chicago O'Hare Airport to Brussels National Airport carrying 390 cows on the main deck. The aircraft was cruising at FL340 over the Irish Sea when the crew received a FIRE MN DK AFT warning. A crew member went onto the main deck but saw no sign of smoke or fire. The crew suspected that the warning was false but decided to carry out the procedure in the Quick Reference Handbook for '*Main Deck Cargo Compartment Suppression'*, which involved donning oxygen masks and initiating a controlled cabin depressurisation and rapid descent. Following the descent, the crew made an uneventful landing at London Heathrow Airport where emergency services attending the aircraft found no evidence of smoke or fire.

The pilot believed that the presence of the cattle led to higher than normal levels of humidity and that this was the cause of the warning.

ACCIDENT

Aircraft Type and Registration:	Cessna 208B Grand Caravan, N208AF
No & Type of Engines:	1 Pratt & Whitney Canada PT6A-114A turboprop engine
Year of Manufacture:	1998 (Serial no: 208B0660)
Date & Time (UTC):	24 September 2011 at 0744 hrs
Location:	South Cerney Airfield, Gloucestershire
Type of Flight:	Aerial work
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to the nosewheel, propeller and leading edges of both wings
Commander's Licence:	Private Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	654 hours (of which 70 were on type) Last 90 days - 35 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he had flown from RAF Weston-on-the-Green for the short flight to South Cerney. Runway 24 was in use; it was a grass runway, 920 m in length and described as wet. The weather was good, with a surface wind from 240° at 5 kt and the temperature was 16°C. The pilot reported that he landed long and that, when applied, the brakes locked. The aircraft slid along the runway, before overrunning the end and passing through the perimeter fence, causing damage to the nosewheel, propeller and wing leading edges. The pilot reported that he sustained minor injuries.

In his brief report, the pilot did not offer any information about the type of approach, aircraft configuration, the decision to continue the approach or why the aircraft may have landed long (a photograph of the accident scene showed the wing flaps apparently only partially extended). Thus, the circumstances of the accident and possible causes remain unclear.

ACCIDENT

Aircraft Type and Registration:	Westland Scout AH1, G-BXRR
No & Type of Engines:	1 Rolls-Royce Nimbus MK 10501 turboshaft engine
Year of Manufacture:	1970
Date & Time (UTC):	24 March 2012 at 1454 hrs
Location:	Near Collingtree, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to tail rotor drive train and landing gear
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	206 hours (of which 34 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The helicopter departed Thruxton at 1416 hrs, with the pilot and three passengers aboard, and arrived over the landing site in Northamptonshire after an uneventful flight. The site was a grassed area with no ground markings adjacent to a hotel car park. The weather was fine, with a surface wind from 330° at 5 kt and a temperature of 19°C.

The pilot flew a "full recce" of the site before making an approach to the grassed area. The helicopter was calculated to be approximately 80 lbs below its maximum landing weight at this point. As he flared the helicopter it did not slow down as quickly as he expected so he increased the flare attitude, following which the helicopter's tail struck the ground. The helicopter started to yaw to the right, so the pilot immediately lowered the collective lever, which resulted in a heavy landing. The pilot and his passengers were uninjured and able to vacate the helicopter normally.

ACCIDENT

Aircraft Type and Registration:	Cessna 152, G-BNIV	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1981	
Date & Time (UTC):	19 March 2012 at 1208 hrs	
Location:	Rochester Airport, Kent	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Extensive	
Commander's Licence:	Student pilot	
Commander's Age:	49 years	
Commander's Flying Experience:	34 hours (of which 31 were on type) Last 90 days - 5 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The student pilot lost control of the aircraft while conducting a 'touch-and-go' landing as part of a solo circuit flying exercise. The aircraft bounced a number of times before the nose leg dug into the grass surface and the aircraft overturned.

History of the flight

The student pilot was flying solo visual circuits under the supervision of his instructor when the accident occurred. The weather was fine, with a surface wind from about 300° at 5 to 10 kt. Runway 34 was in use, being a grass runway 963 m long with a Landing Distance Available of 773 m. The pilot had already completed 2 hours of solo circuit flying during his training, and had previously flown both dual and solo from Runway 34.

The exercise began with three dual touch-and-go circuits flown with the pilot's flying instructor, during which minor technique points were addressed. These included smooth resetting of flap after landing to reconfigure the aircraft during the touch-and-go. The pilot then commenced his solo circuit exercise. He felt that his circuits were satisfactory in the good conditions, and that his landing point and flap handling after landing benefited from earlier instruction.

The third circuit and landing were similar except that, as the aircraft rolled along the runway after landing and the pilot reset the flaps for takeoff, it encountered a surface undulation and became airborne again. This feature was a known runway characteristic and one which the pilot had previously dealt with, but on this occasion it caught him unaware. The aircraft bounced a number of times and eventually the nose leg dug into the runway, causing the aircraft to flip forward onto its back. The pilot suffered only superficial grazing and was able to exit through his left window; the left door had suffered damage to its hinges and was initially difficult to open.

The pilot's flying instructor was satisfied with his student's ability to complete the solo exercise safely in the prevailing conditions. From the clubhouse, he observed the pilot's first two approaches. They were made at the correct angle and the pilot appeared to correct a slightly fast first approach. Both landings were entirely satisfactory. The third approach and landing were similar to the second and also satisfactory. However, the aircraft was then seen to start a short series of minor bounces, at the end of which its nose dug into the ground and it turned over, at fairly low speed.

Flying school personnel who examined the witness marks on the grass runway surface concluded that the aircraft had bounced at least twice, possibly more, and that at least one of the bounce landings was primarily on the nosewheel.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BSOT
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1981
Date & Time (UTC):	25 February 2012 at 1300 hrs
Location:	West of Swansea Airport
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Fuselage and rudder damaged
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	8,630 hours (of which 4,000 were on type) Last 90 days - 118 hours Last 28 days - 33 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

At approximately 400 ft agl, after taking off from Swansea Airport on a training flight, the instructor heard a loud bang followed by severe airframe vibration and a significant reduction in engine power. He elected to make an immediate forced landing in a field. The aircraft touched down without incident, but the instructor was unable to stop the aircraft before it hit the boundary hedge. Both the instructor and student were uninjured and able to evacuate the aircraft unaided. Examination of the engine identified that a spark plug had failed and released from one of the cylinder heads.

ACCIDENT

Aircraft Type and Registration:	Rans S6-116 Coyote II, G-BVCL
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	1993
Date & Time (UTC):	25 March 2012 at 1410 hrs
Location:	Private airstrip near Alloa, Clackmannanshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left wing struts and nosewheel damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	66 hours (of which 14 were on type) Last 90 days - 13 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft failed to become airborne from a farm strip. The pilot prolonged the takeoff roll in further attempts to become airborne, before deciding to reject the take off. The aircraft ran into a hedge at the end of the strip at low speed.

History of the flight

The pilot kept G-BVCL at Fife Airfield near Glenrothes, but was exploring the possibility of operating it from a field at his farm, for which he had prepared a 320 m strip. On the day of the accident he flew the aircraft there from Fife accompanied by his son. The wind was calm, with an air temperature of 22°C and QNH of 1032 HPa.

After a practice approach to the strip, the pilot landed the aircraft and his son got out. The pilot then completed several takeoffs and landings in both directions without incident. The strip was not entirely level, but the pilot had previously rolled it and cut the grass short, and was satisfied that the aircraft's performance was such that takeoffs could be made safely in either direction at maximum weight. His son re-boarded the aircraft for departure.

The pilot commenced takeoff uphill but, as he rotated the aircraft, found it "reluctant" to become airborne. He lowered the nose to gain speed, then tried again to raise the nose, but with the same result. He steered the aircraft towards a slight down slope to gain speed, but realised that takeoff would not be possible and closed the throttle. The aircraft hit a hedge at approximately 20 kt, sustaining damage to its left wing struts and nosewheel. The occupants, who were both wearing lap and diagonal seat straps, were uninjured.

The pilot commented that his inexperience had contributed to the accident. He observed that he should have rejected the takeoff when the aircraft first failed to become airborne, and that placing markers on the strip would have helped him to assess takeoff performance and with a decision to stop. He added that holding the aircraft in a nose high attitude increased drag significantly, and that further drag may have been caused by the uneven surface. The warm conditions and lack of headwind may have contributed to the accident.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-FIRS
No & Type of Engines:	1 Lycoming O-360-J2A piston engine
Year of Manufacture:	1998
Date & Time (UTC):	16 January 2012 at 1305 hrs
Location:	Lake Vyrnwy, Powys
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Helicopter destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	61 hours (of which 50 were on type) Last 90 days - None Last 28 days - None
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquires by AAIB

Synopsis

In the final stages of an approach to a hotel helipad the pilot was unable to stop a right yaw, and the helicopter completed several rotations with decaying main rotor rpm before impacting the ground. The helicopter suffered severe damage and was largely consumed in a subsequent fire. The two occupants suffered minor injuries.

History of the flight

The pilot planned to fly from Kemble Airfield to a helicopter landing site adjacent to Lake Vrynwy in Wales. He had not flown for more than three months and was required to fly three solo circuits at Kemble before departing with his passenger for their destination. The pilot decided the weather was suitable for the intended flight with light surface winds and a probable wind for the route of 165° at 20 kt. Takeoff mass with full fuel and two occupants was calculated as 1,364 lbs, just below the maximum authorised mass of 1,370 lbs.

The pilot telephoned the instructor, who was not available at the airfield, concerning removal of the dual controls but the flight itself was not discussed. With departure thus delayed, and mindful of the need to complete the flight in daylight hours, the pilot departed directly with his passenger, having forgotten to carry out the three solo circuits.

The transit to Vrynwy was uneventful. A weather report obtained from Welshpool Airfield reported calm wind and a QNH of 1024 hPa. The landing site, in hilly terrain at about 1,000 ft amsl, was a marked helipad on a small grass field in the grounds of a hotel, which the pilot located without difficulty.

The pilot flew past the site about 1,000 ft above it on a left downwind leg, noting a windsock showing a south-easterly wind. He turned left onto final approach, establishing on what appeared to be a normal approach path, and set carburettor heat (which had been in use during the flight) to off. The pilot described approaching the site broadly into wind, with a gentle turn to the right in the later stages of the approach.

As the helicopter approached the landing site it started to yaw right. The pilot was unable to stop the yaw and the helicopter completed several full rotations. The pilot believed that he may have raised the collective lever further whilst rotating and recalled hearing the 'low rotor rpm' warning horn. Still rotating, the helicopter dropped and landed heavily on sloping ground. The right landing skid collapsed but the helicopter remained upright, allowing the pilot and his passenger to escape.

The helicopter had sustained severe damage but the engine was still running. Witnesses reported that it ran for several minutes before a fire broke out, consuming a large part of the structure. Both occupants were taken by air ambulance to hospital, where their injuries were found to consist mainly of cuts and bruises.

The pilot was unable to account for the loss of control. He believed that main rotor rpm had decayed significantly by the time the helicopter struck the ground.

Accident site information

Photographs of the accident site showed that the helicopter had struck the ground with little or no horizontal movement. The right skid had struck first, while it was pointing down a moderate slope, and had collapsed as the helicopter continued to rotate to the right, coming to rest facing approximately across the slope. There was evidence that the helicopter had rolled to the right on initial impact, with the rotor blades and the horizontal stabiliser making relatively light contact with the upward slope. The rotor blades appear to have been rotating but with low energy, the collective lever at, or very close to, the fully raised position. The Perspex transparencies had shattered and several large pieces were lying some distance from the wreckage.

Operating company's comments

The pilot booked the aircraft on a self-hire basis through an automated booking system. Because of his lack of currency, he would automatically have been reminded that he was required to complete three takeoffs and landings before departing on a flight carrying a passenger. The helicopter operator commented that pilots intending on self-fly hire would normally have their flight preparations overseen by an instructor. In this case, other duties took the available instructors away from the flight preparation area and an oversight in the operations diary had left them unaware of the intended flight.

The arrangements for self-fly hire were stated in the operator's flying order book and, on previous occasions, the pilot had arranged a refresher flight or discussed his intentions, but did not do so on this occasion. The operator subsequently reviewed its procedures and introduced additional measures to ensure that flying order book procedures were known and complied with.

Discussion

The loss of control occurred at low speed close to the landing site. As the helicopter slowed, there would have been an increasing power requirement, possibly rapid, as translational lift was lost. The cause of the initial right yaw is not certain but may have been aggravated by main rotor vortices blowing onto the tail rotor as the aircraft turned slightly right to approach the pad, placing the relative wind from forward and to the left of the helicopter. Equally, the pilot may have been slow to apply left yaw pedal as power was increased. Whatever the precise combination of factors, it is likely that the pilot's low overall experience level and lack of recency contributed to the loss of control.

Once the right yaw had started, an attempt to stop it with full opposite yaw pedal would have meant a significant extra power demand. Once the main rotor rpm started to fall, as evidenced by the warning horn, the amount of yaw the tail rotor was capable of producing would have reduced rapidly. Further main rotor rpm decay would have been hastened by application of 'up' collective lever and an increasingly rapid descent would have ensued, from which recovery would not have been possible.

ACCIDENT

Aircraft Type and Registration:	Aeroprakt A22 Foxbat, G-GFOX
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2005
Date & Time (UTC):	5 April 2012 at 1650 hrs
Location:	Shifnal Airfield, Shropshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Rear spar buckled
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	294 hours (of which 252 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

While taxiing after a local flight the left wingtip contacted the corner of a hangar. Damage to the wingtip was minor but subsequent inspection revealed that the rear spar was buckled near the wing root. The pilot commented that a recent bereavement had distracted him from carrying out a routine manoeuvre.

SERIOUS INCIDENT

Aircraft Type and Registration:	Aeroprakt A22L Foxbat, G-CEWR
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2008
Date & Time (UTC):	5 November 2011 at 1300 hrs
Location:	Otherton Airfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to elevator and rudder anti-balance tab control horn
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	713 hours (of which 497 were on type) Last 90 days - 11 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Shortly after takeoff the pilot experienced "severe vibration" which lasted for about 30 seconds after which the rudder jammed in the neutral position. The pilot was able to maintain control of the aircraft and landed back on the departure runway. The vibration had been caused by a rudder 'flutter' event which was caused by the seizure of the rudder anti-balance tab's spring hinge. Two modifications have been developed by the Light Aircraft Association to prevent a recurrence.

History of the flight

After a normal pre-flight inspection the pilot departed from Runway 34 at Otherton. At a height of about 200 feet and an airspeed of 60 kt the pilot experienced "severe vibration". He immediately banked left to follow the circuit pattern to make an emergency landing. The vibration stopped after about 30 seconds and then he noticed that the rudder had jammed in the neutral position. He maintained control of the aircraft with aileron and elevator and landed safely on Runway 34.

Aircraft description

The Aeroprakt A22L Foxbat is a kit-built three-axis microlight aircraft (Figure 1) operated under a Permit to Fly. When the aircraft type was first flight tested in the UK for a Permit to Fly it was discovered that the rudder did not return to a neutral position after deflection. To solve this problem a rudder anti-balance tab was fitted which provided a centring force when deflected. This tab is attached to the trailing edge of the rudder with a spring hinge that is loaded to deflect the tab to the right. A cable attached between the airframe and the lower leading edge of the tab provides an opposing force to the spring. When the rudder is neutral the tab is neutral; when the rudder is deflected left the tab is deflected left and the cable is placed under increasing tension; and when the rudder is deflected right the tab is deflected right under spring tension while the cable slackens (Figure 2).

Figure 1

G-CEWR prior to the accident
(photograph courtesy Graham Wiley)

Aircraft examination

G-CEWR was examined by an engineer from the Light Aircraft Association (LAA). He discovered that the control horn, which connects the cable to the tab, had bent downwards and had impinged on the elevator, leading to damage to the elevator's upper surface and restricting movement of the rudder (Figure 3). He also discovered that the anti-balance tab's spring hinge had seized, which meant that there was no spring return force and therefore the tab could flap freely from left to right. After the spring hinge was cleaned and lubricated the spring force returned and the tab operated correctly during rudder movement. The control horn was then

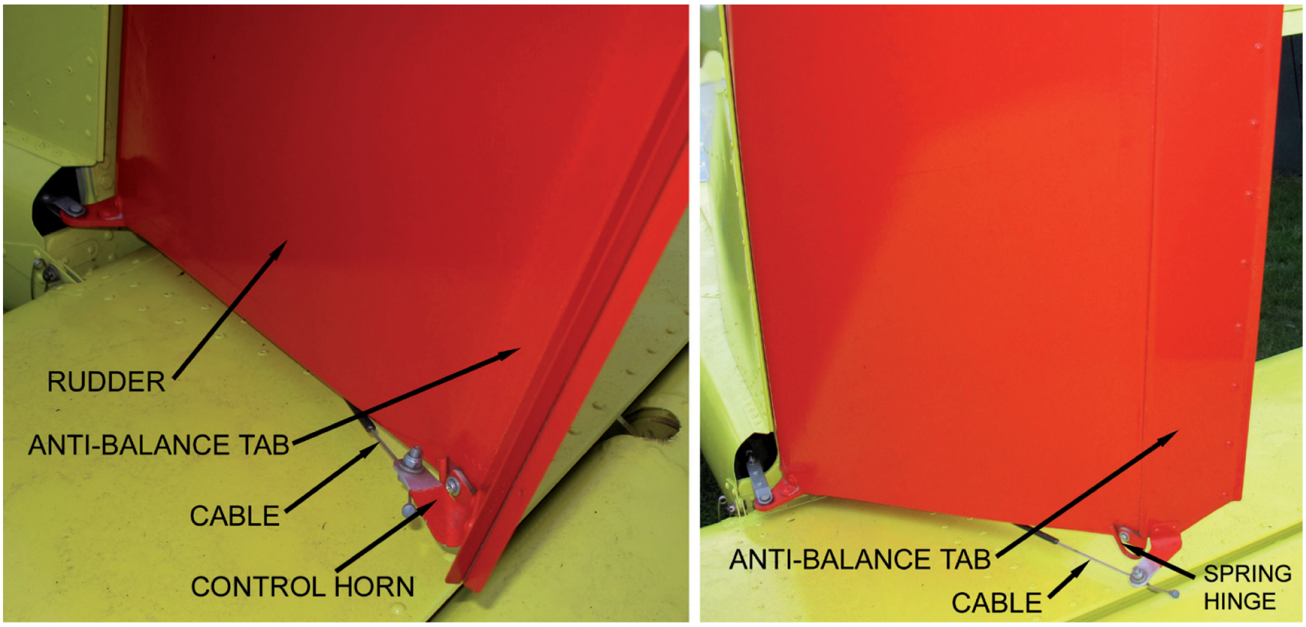

Figure 2

Rudder of a similar Foxbat A22L;
full left rudder deflection and full left anti-balance tab deflection (left image);
full right rudder deflection and full right anti-balance tab deflection (right image)

replaced and the bolt securing the cable was orientated 'head down' (as in Figure 2) which is how the bolt should have been attached to provide maximum clearance. The aircraft was then test-flown and the rudder anti-balance system worked normally.

Safety action

The LAA concluded that the vibration experienced by the pilot had been a type of rudder 'flutter' event which was caused by the seizure of the anti-balance tab's spring hinge. This allowed the tab to flap freely from left to right and set up a resonant frequency. The consequent high loads at the control horn caused it to bend downwards, jamming the rudder against the elevator.

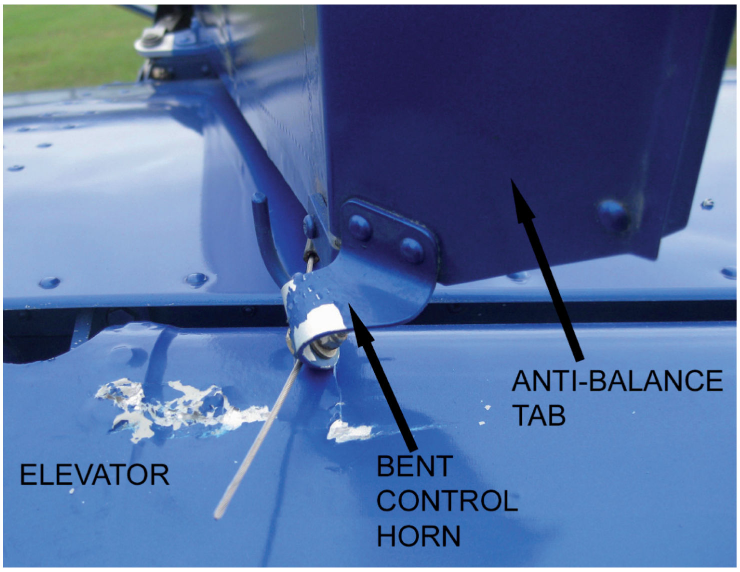

Figure 3

Bent control horn and damaged elevator on G-CEWR
(photograph courtesy Light Aircraft Association)

In response to this incident the LAA published Airworthiness Information Leaflet (AIL) entitled '*Aeroprakt A22L Foxbat, Pre-Flight Functioning Checks of Rudder Anti-Balance Tab'* (MOD/317/002 dated 22/11/2011). The AIL required that prior to further flight and during every pre-flight inspection a check of the range and freedom of movement of the rudder anti-balance tab was carried out. It stated that this could be accomplished by pressing down on the tailplane (to take the weight off the nosewheel) and moving the rudder fully left and right, while checking that spring pressure was maintained.

However, on 10 January 2012, despite these checks having been completed, another similar incident of rudder 'flutter' occurred to a Foxbat A22L (registration G-CGWP) which resulted in the anti-balance tab detaching at the lower hinge and causing the elevator to jam in flight. Full details on this serious incident are published in this bulletin (Bulletin 7/2012). As a result of this incident the LAA published an AIL entitled '*Aeroprakt A22L Foxbat, Concerns about Rudder Flutter, Temporary Grounding*' (MOD/317/003 dated 16/01/2012) which grounded the aircraft type until a modification could be developed. This AIL affected all Foxbat A22L aircraft fitted with a rudder anti-balance tab, which was a modification fitted to all but one UK-registered aircraft. On 13 March 2012 the LAA published Airworthiness Alert '*Aeroprakt A22L Foxbat, Modification Approval for changes to Rudder Anti-Balance Tab*' (AWA/12/02) which detailed two modification options, and installing either one would remove the flight restriction. The first modification replaces the tab cable with a pushrod and adds doublers to the tab hinge attachment (LAA Modification Approval 13310). The second modification removes the anti-balance tab and replaces it with a rudder centring spring to provide the necessary centring force that was provided by the tab (LAA Modification Approval 13311).

SERIOUS INCIDENT

Aircraft Type and Registration:	Aeroprakt A22L Foxbat, G-CGWP
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2011
Date & Time (UTC):	10 January 2012 at 1510 hrs
Location:	Enstone Airfield, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to rudder anti-balance tab, rudder and elevator
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	329 hours (of which 60 were on type) Last 90 days - 35 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Shortly after departure the aircraft started to "shudder violently". The pilot reduced power and the shuddering stopped, but then the rudder jammed and subsequently the elevator also jammed. The pilot was able to make a safe landing using ailerons to steer the aircraft and engine power to control the descent rate. The aircraft shuddering had been caused by a rudder 'flutter' event and the rudder and elevator jammed when the lower hinge of the rudder anti-balance tab separated causing the tab to move aft. The exact cause of the rudder 'flutter' and the hinge separation could not be determined. However, the aircraft type was briefly grounded following this incident and two modifications have been developed by the Light Aircraft Association to prevent a recurrence.

History of the flight

After completing the pre-flight checks, including a freeplay check of the rudder anti-balance tab, the pilot departed from Runway 26 at Enstone. About 4 minutes after departure, while approaching 2,000 feet, the aircraft started to "shudder violently". The pilot thought he had an engine problem so he reduced power and the shuddering stopped, but then he realised that the rudder was jammed and the aircraft was yawing to the right. As the pilot applied pressure to the left rudder pedal he heard a bang and the rudder moved to a neutral position and then jammed again. He then discovered that the elevator was also jammed. Using ailerons to steer the aircraft, and engine power to control the descent rate, he turned back towards Enstone and declared a PAN. He established the aircraft on a long final to Runway 26 and decided to keep the flaps up to avoid any pitch changes. Shortly before touchdown he applied a burst of power to raise the nose and the aircraft touched down normally on its main wheels. After touchdown the nosewheel, which is linked to the rudder, could not be controlled so the aircraft ran off to the left of the runway and onto the grass where it came to rest.

Figure 1

Aeroprakt A22L Foxbat of the same configuration and colour as G-CGWP
(photograph courtesy Graham Wiley)

Aircraft description

The Aeroprakt A22L Foxbat is a kit-built three-axis microlight aircraft (Figure 1) operated under a Permit to Fly. When the aircraft type was first flight tested in the UK for a Permit to Fly it was discovered that the rudder did not return to a neutral position after deflection. To solve this problem a rudder anti-balance tab was fitted which provides a centring force when deflected. This tab is attached to the trailing edge of the rudder with a spring hinge that is loaded to deflect the tab to the right. A cable attached between the airframe and the lower leading edge of the tab provides an opposing force to the spring. When the rudder is neutral the tab is neutral; when the rudder is deflected left the tab is deflected left and the cable is placed under increasing tension; and when the rudder is deflected right the tab is deflected right under spring tension while the cable slackens (Figure 2).

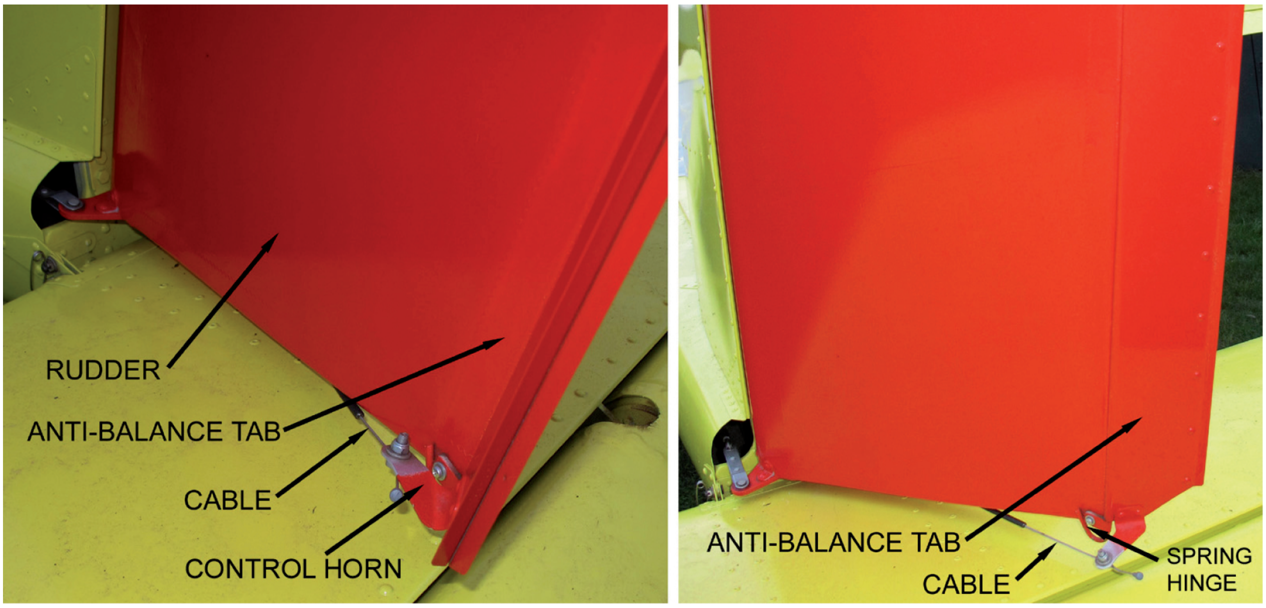

Figure 2

Rudder of a similar Foxbat A22L;
full left rudder deflection and full left anti-balance tab deflection (left image);
full right rudder deflection and full right anti-balance tab deflection (right image)

Aircraft examination

G-CGWP was examined by an engineer from the Light Aircraft Association (LAA). The anti-balance tab was found to have separated from the rudder at the lower hinge (Figure 3), allowing the tab to move aft and damage the elevator. The damage to the elevator was consistent with it having been caused by the control horn which had bent downwards (Figure 4). The control horn cable was also found to have failed. The single screw and nut which had attached the lower tab hinge was missing. The top two hinge screws were found to be loose and there was evidence of rubbing on the tab leading edge. The tab was free to move and the spring hinge was working, although there was a clicking noise during rotation, indicating some extra resistance at one point in the tab's range of movement.

The LAA engineer was not able to determine the initiating cause of failure but theorised that if the lower hinge screw had failed or separated first, then that would explain the aft movement of the tab and the rudder flutter due to a reduction of spring force from the spring hinge. The rudder movement would then have stopped once the control horn jammed inside the elevator skin, thus also causing the elevator to jam. The cyclic loads that overloaded the pitch horn probably also caused a fatigue failure of the cable. Alternatively, the lower hinge screw could have failed or separated due to a 'flutter' event caused by some other factor. The evidence of rubbing on the leading edge of the tab could indicate an over-close fitment when the aircraft was manufactured, or it could have been a result of the loose hinges found.

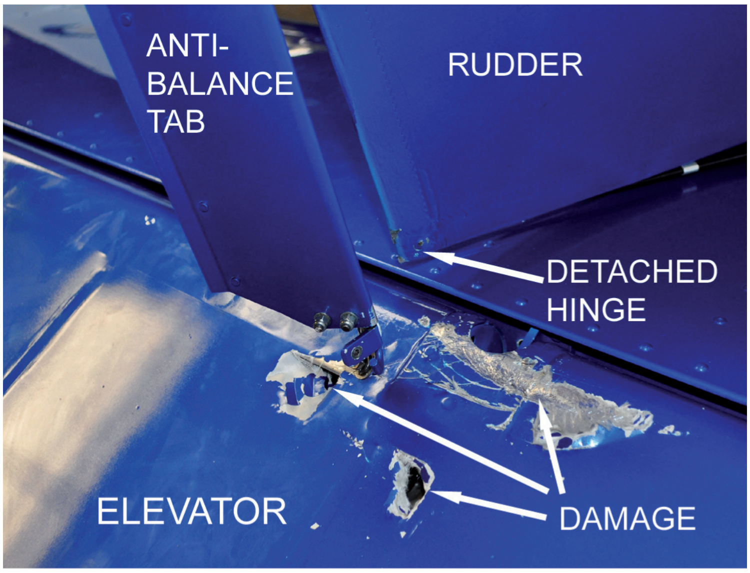

Figure 3

Damaged elevator and separated anti-balance tab hinge on G-CGWP
(photograph courtesy Light Aircraft Association)

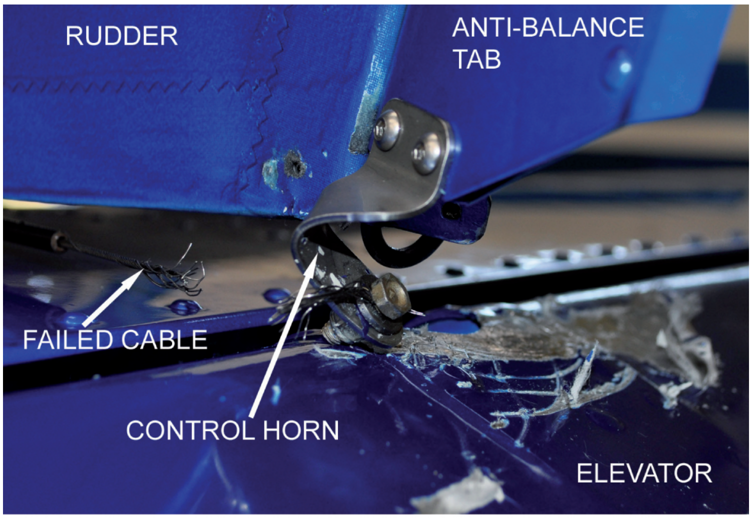

Figure 4

Bent control horn and failed cable on G-CGWP
(photograph courtesy Light Aircraft Association)

Previous similar incident

A previous similar rudder 'flutter' event occurred on a Foxbat A22L (registration G-CEWR) on 5 November 2011, also reported in this bulletin (Bulletin 7/2012). In this incident the 'flutter' was caused by seizure of the anti-balance tab spring hinge. In response to this incident the LAA published Airworthiness Information Leaflet (AIL) entitled '*Aeroprakt A22L Foxbat, Pre-Flight Functioning Checks of Rudder Anti-Balance Tab'* (MOD/317/002 dated 22/11/2011). The AIL required that prior to further flight and during every pre-flight inspection a check of the range and freedom of movement of the rudder anti-balance tab was carried out. It stated that this could be accomplished by pressing down on the tailplane (to take the weight off the nosewheel) and moving the rudder fully left and right, while checking that spring pressure was maintained. The pilot of G-CGWP stated that he was aware of the AIL and had carried out this check prior to the incident flight.

Safety action

Due to the similar nature of the G-CGWP and G-CEWR incidents and the serious risk of control jams when a rudder 'flutter' event occurs the LAA decided to ground the UK fleet of Foxbat A22L aircraft with the publication of the AIL entitled '*Aeroprakt A22L Foxbat, Concerns about Rudder Flutter, Temporary Grounding*' (MOD/317/003 dated 16/01/2012). This AIL affected all Foxbat A22L aircraft fitted with a rudder anti-balance tab, which was a modification fitted to all but one UK-registered aircraft.

On 13 March 2012 the LAA published Airworthiness Alert '*Aeroprakt A22L Foxbat, Modification Approval for changes to Rudder Anti-Balance Tab*' (AWA/12/02) which detailed two modification options, and installing either one would remove the flight restriction. The first modification replaces the tab cable with a pushrod and adds doublers to the tab hinge attachment (LAA Modification Approval 13310). The second modification removes the anti-balance tab and replaces it with a rudder centring spring to provide the necessary centring force that was provided by the tab (LAA Modification Approval 13311).

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 15, G-MYLC
No & Type of Engines:	1 Rotax 503-2V piston engine
Year of Manufacture:	1993
Date & Time (UTC):	19 February 2012 at 1405 hrs
Location:	Kirkbride Airfield, near Carlisle
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to windshield; damage to parked aircraft's wing, wheel spat and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	79 years
Commander's Flying Experience:	346 hours (of which 89 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and photographs of the scene

Synopsis

The pilot lost control of the flex-wing microlight during taxi and it struck a fixed-wing microlight which was parked adjacent to the taxiway.

Description of the event

The aircraft, a flex-wing microlight, was being taxied, prior to flight, along a narrow and constricted taxiway. A second, fixed-wing microlight was parked adjacent to the taxiway but clear of it. It had reportedly been moved further back from the taxiway to provide additional clearance for the flex-wing to pass.

The flex-wing pilot reported that his aircraft was controlled on the ground by a pivoting cross-bar connected directly to the nosewheel, and on which the pilot's feet rested. To steer to the right, the pilot would press with his left foot. Connected to the left side of the cross-bar was a foot-operated brake, and on the right side was a foot-operated throttle.

At engine idle speed, the aircraft moved across the hard surface at a jogging pace. In order to slow down as the microlight approached the parked aircraft, the pilot attempted to operate the brake by pressing forward with his left foot. This was not wholly effective, so he pressed harder. This still did not slow the microlight, but did cause it to turn to the right, towards the parked aircraft. To counter this, the pilot pressed forward with his right foot but, instead of reversing the turn as he intended, his foot operated the throttle and accelerated the microlight towards the parked aircraft.

The microlight struck the parked aircraft at an angle of about 45°, pushing it backwards a short distance until its left wheel spat contacted concrete blocks behind. An initial inspection showed only light damage to the flex-wing. The fixed-wing microlight suffered a damaged wheel spat, damage to its left wing leading edge and pitot tube (believed to have been caused through contact with the flex-wing's 'A' frame), and light damage to the propeller, believed to have been caused by the flex-wing's flying wires.

Miscellaneous

This section contains Addenda, Corrections and a list of the ten most recent Aircraft Accident ('Formal') Reports published by the AAIB.

The complete reports can be downloaded from the AAIB website (www.aaib.gov.uk).

BULLETIN CORRECTION

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BOER
Date & Time (UTC):	16 February 2012 at 1755 hrs
Location:	Coventry Airport
Information Source:	Aircraft Accident Report Form

AAIB Bulletin No 6/2012, page 51 refers

In the report published in Bulletin 6/2012 the second aircraft involved was incorrectly identified as being a PA-24 instead of a **PA-28**. Additionally, the commander held a **Private Pilot's Licence** as well as the National Private Pilot's Licence stated.

The online version of this report was corrected before publication online.

BULLETIN CORRECTION

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BOFZ
Date & Time (UTC):	4 February 2012 at 1150 hrs
Location:	Newcastle Airport
Information Source:	Aircraft Accident Report Form submitted by the pilot

AAIB Bulletin No 5/2012, page 100 refers

The original report incorrectly specified the commander's flying experience as being 1,458 hours (of which 1,243 were on type). The correct number of hours on type is 686.

The online version of this report was corrected on 22 May 2012.

TEN MOST RECENTLY PUBLISHED FORMAL REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

1/2010 Boeing 777-236ER, G-YMMM
at London Heathrow Airport
on 17 January 2008.
Published February 2010.

2/2010 Beech 200C Super King Air, VQ-TIU
at 1 nm south-east of North Caicos Airport, Turks and Caicos Islands, British West Indies
on 6 February 2007.
Published May 2010.

3/2010 Cessna Citation 500, VP-BGE
2 nm NNE of Biggin Hill Airport
on 30 March 2008.
Published May 2010.

4/2010 Boeing 777-236, G-VIIR
at Robert L Bradshaw Int Airport
St Kitts, West Indies
on 26 September 2009.
Published September 2010.

5/2010 Grob G115E (Tutor), G-BYXR
and Standard Cirrus Glider, G-CKHT
Drayton, Oxfordshire
on 14 June 2009.
Published September 2010.

6/2010 Grob G115E Tutor, G-BYUT
and Grob G115E Tutor, G-BYVN
near Porthcawl, South Wales
on 11 February 2009.
Published November 2010.

7/2010 Aerospatiale (Eurocopter) AS 332L Super Puma, G-PUMI
at Aberdeen Airport, Scotland
on 13 October 2006.
Published November 2010.

8/2010 Cessna 402C, G-EYES and
Rand KR-2, G-BOLZ
near Coventry Airport
on 17 August 2008.
Published December 2010.

1/2011 Eurocopter EC225 LP Super Puma, G-REDU
near the Eastern Trough Area Project Central Production Facility Platform in the North Sea
on 18 February 2009.
Published September 2011.

2/2011 Aerospatiale (Eurocopter) AS332 L2 Super Puma, G-REDL
11 nm NE of Peterhead, Scotland
on 1 April 2009.
Published November 2011.

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