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SPECIAL BULLETINS

None

COMMERCIAL AIR TRANSPORT

GENERAL AVIATION

SPORT AVIATION / BALLOONS

ADDENDA and CORRECTIONS

None

CONTENTS (Continued)

(ALL TIMES IN THIS BULLETIN ARE UTC)

INCIDENT

Aircraft Type and Registration:	Airbus A319-131, G-EUOF
No & Type of Engines:	2 IAE V2522-A5 turbofan engines
Year of Manufacture:	2001
Date & Time (UTC):	12 February 2007 at 0750 hrs
Location:	Stand 415, Terminal Four, London (Heathrow) Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 57
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to cushion on airbridge shroud. (No damage to aircraft)
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	6,550 hours (of which 6,350 were on type) Last 90 days - 150 hours Last 28 days - 48 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was taxiing on to Stand 415 following the guidance provided by the Stand Entry Guidance (SEG) system. The stand's airbridge had previously been repositioned in order for its floor to be replaced, in accordance with an Airside Works Instruction (AWI) drawn up by the airport operator. The AWI specified that a marshaller was required for all 'live' arrivals on the stand. The airline operator's Turn Round Manager (TRM) had not been made aware of this requirement and had earlier switched on the SEG system. No marshaller attended the aircraft's arrival and the commander considered that the airbridge was sufficiently clear. On seeing that the aircraft's left wing tip was about to strike the airbridge the TRM, and a colleague, gave the 'stop' sign and activated the stop button on the SEG system. The aircraft stopped 4 metres short of its designated stop line, during which the left wing tip made contact with the curtain on the airbridge. There were no injuries and the aircraft was undamaged. One recommendation is made to the airport operator.

History of the flight

The aircraft was taxiing on to Stand 415 at Terminal Four following its arrival at the airport. Earlier the operator's TRM had switched on the stand's Stand Entry Guidance system (SEG).

Before taxiing on to the stand, the flight crew confirmed that the SEG was switched on and that it indicated their aircraft type. Also, the commander, who was the handling pilot, and co-pilot each checked that their respective sides of the stand were clear of obstacles. While doing so, the commander noticed that red and white barrier markers had been placed around the base of the airbridge on the left of the stand. Unaware of any work in progress, and with the SEG selected on, he did not consider that the airbridge represented an obstacle and, consequently, he taxied the aircraft forward following the indications on the SEG system. When the system indicated that G-EUOF had 5 metres to run to the Airbus A319 stop position, the commander noticed the TRM, on the stand ahead of the aircraft, giving the stop sign with her arms crossed and he saw the guidance system change to a 'STOP STOP' message. The commander applied the brakes and the aircraft came to a halt 4 metres short of its normal stop position.

The crew of another aircraft, which had just pushed back off Stand 415 and was stationary on the taxiway, had observed G-EUOF taxiing on to the stand and informed ATC, by radio, that the aircraft's left wing tip had struck the jetty. This was the first that the flight crew in G-EUOF were aware that their aircraft had made contact with an obstacle. ATC initiated a Ground Incident and the Aerodrome Fire and Rescue Service (AFRS) and the police attended. It was established that the aircraft's left wing tip was in contact with the flexible curtain at the end of the airbridge. However, there was no sign of any fluid leakage or fire hazard. After assessment, a tug vehicle was summoned and the aircraft was pushed back "2 to 3 feet", which was sufficient to provide a gap between the aircraft's left wing tip and the jetty, enabling the passengers to be disembarked using airstairs. Whilst the wing tip fairing ahead of the tip fence had some marks on the surface, from light contact with the airbridge, there was no damage to the aircraft.

Recorded information

Both the Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) were recovered by the AAIB and both recorders captured the incident.

The CVR confirmed a transmission from the aircraft previously occupying Stand 415, indicating that they were clear and had "PASSED ON TO THE NEXT POSITION". One minute later, during taxi on to the stand, the co-pilot confirmed "OK 415 TURNED ON", referring to the SEG. The FDR confirmed that G-EUOF then approached the stand with a groundspeed of around 5 kt, which slowly decayed until the aircraft stopped. Once stopped, the co-pilot mentioned "THAT SAID FIVE METRES BEFORE IT SAID STOP", referring to the remaining countdown distance on the SEG.

Airport information

Figure 1 shows the extended airbridge. Note that this figure has been constructed by 'stitching' several photographs together and hence there is some distortion of the image.

Stand 415 was the subject of an airport operator's Airside Works Instruction (AWI), which gave notification of work being carried out to replace the floors in a number of 'jetties' (airbridges) at Terminal Four. The AWI covered the period 11 to 17 February 2007 and detailed the closing and opening times for Stand 415 and the fact that, when open between 12 and 15 February, it would be restricted to a maximum aircraft size of an Airbus A321, with no jetty service.

The AWI also stated that during the night of 11 February the jetty would be extended parallel to Stand 415's clearway, that worksite protection would be put in place and that, on completion of this activity, the contractor

Figure 1
Extended airbridge at Stand 415

would inform the airport's Airside Operations Safety Unit (AOSU) that the stand was ready for inspection and re-opening. The AOSU was then required to inspect the stand and assess the maximum size of aircraft that could use it with this arrangement. That information was then to be passed to the airline operator via the airport operator's Senior Operations Controller.

The AWI emphasised that for the period 12 to 15 February:

> *'**a Leader** (provided by AOSU) **will be required to marshall ALL live arrivals on to the stand while the jetty is positioned parallel to the clearway.**'*

A marshaller was initially nominated for G-EUOF's arrival on Stand 415 but was then recalled to the AOSU for a shift changeover before being able to provide the service.

The UK Aeronautical Information Publication (AIP) entry for London Heathrow contained the advice:

> *'Pilots should not enter a stand unless the Stand Entry Guidance System is illuminated or a marshaller has signalled clearance to proceed.'*

It also advised:

> *'Stand Entry Guidance is provided by APIS/APS, AGNIS/PAPA, AGNIS/Mirror, or AGNIS/Stop Arrow (painted on the apron), or Safedock. The type of stopping guidance is marked beside the APIS/APS, AGNIS or Safedock unit at the head of the stand.*
>
> *Flight crew should be aware that the SEG systems have emergency 'stop' buttons located at apron level and in the airbridges. Activation by ground personnel of any of these buttons will cut the power to the SEG and additionally activate a flashing 'STOP' message at the head of the stand within the pilot's line of sight. When using AGNIS/PAPA, AGNIS/Mirror or AGNIS/Stop Arrow, a member of the aircrew should keep the emergency STOP sign within his/her line of sight during the final moments of the parking manoeuvre.'*

There was no information in the Notices to Airmen (NOTAMs) current at the time to advise the flight crew of the requirement for a marshaller to meet 'live' aircraft arrivals on Stand 415. Nor was there any information in the airline operator's briefing material for flight crew. This was because the procedures detailed in the AIP provided for stand entry guidance by a marshaller or the SEG system.

Airline operator

The airline operator had been advised on 9 February of the work planned for Stand 415. For three days, from 0430 hrs on 12 February, the stand would be restricted to aircraft of the size of an A321 (or smaller); that the jetty would be extended parallel to the stand clearway; that there would be no jetty service, and that all 'live' arrivals would be marshalled.

The airline operator held a conference call at 0730 hrs on 12 February which included the operator's Heathrow Airport Centre (APC) and the operator's Turn Round Shift Manager (TRSM) at Terminal Four. The Terminal Four TRSM later stated that she had been advised that Stand 415 was restricted to A319 aircraft and the A320/A321 aircraft used by one of her company's franchise operators. However, she did not recall being told that aircraft would be marshalled on to the stand.

After G-EUOF had landed, but before it had taxied on to Stand 415, the TRM, who had been allocated that flight number and told that the aircraft was an A319, walked from the operator's Terminal Four office to Stand 415. She checked that the stand was clear of equipment, entered the aircraft type details into the Stand Entry Guidance (SEG) system and switched the system on, confirming that the lights were illuminating correctly. She then noticed that the jetty was extended out to the side of the stand and went back into the terminal building to check on the computer, at the TRM's desk, to see whether the stand required a marshaller. A colleague of hers was standing next to the computer screen and, in response to the TRM's enquiry, advised her that the computer only indicated that the jetty was unserviceable. However, that colleague had dispatched the previous aircraft, another A320 series aircraft, to depart from the stand. That aircraft had earlier been towed on to the stand before being pushed back off it, and the colleague had noticed that when it was pushed back its left wing had been close to the airbridge. In the light of that, he expressed the opinion that a marshaller might be necessary for the inbound aircraft. They both returned to stand 415 to see if a marshaller was available on the ramp. On arrival they found no marshaller but saw G-EUOF taxiing on to the stand. Realising that the aircraft's left wing was going to strike the jetty, the TRM tried to catch the attention of the commander of the aircraft using the 'crossed arms' stop signal, while her colleague activated the stop button on the SEG.

Procedures - flight crew

The operator's Flight Crew Orders for the A319 fleet gave the following advice for parking an aircraft on stand:

> *'When approaching the assigned parking stand, Flight Crew must take particular care to ensure that the aeroplane may be parked safely….*
>
> *The illumination or activation of any guidance system is not a dependable indication that the stand is clear for use. If the aeroplane cannot be parked safely, then it must be brought to a halt and any obstruction removed before proceeding.*
>
> *If there is no SEG, or if the system is either unserviceable or not calibrated for the aircraft type, then the aeroplane must be marshalled on to stand. Remote holding stands may have specific published procedures.*
>
> *Whenever a "dynamic" (e.g. APIS ……) guidance system is employed on a stand, Flight Crew should ensure that the system is operating and indicating*

> *the correct aircraft type before final alignment onto the stand centerline.'*

The cautionary guidance in this extract reflects the advice given in the UK Civil Aviation Publication (CAP) 637, entitled *Visual Aids Handbook*, which states:

> *'A pilot* ***should not*** *assume that a stand is safe to enter simply because the stand (A)VDGS [(Advanced) Visual Docking Guidance System] is active or lit. Where ground handling personnel are not present on the stand or if the pilot has any doubt about the position of any equipment on* ***or NEAR*** *to the stand, the aircraft should be stopped immediately and assistance requested.'*

During the investigation, it was noted that the left wing tip was difficult to see from the commander's seat on the flight deck: this was particularly relevant as his concentration would have been centred on the information being displayed on the SEG system.

Procedures - ground crew

The airport operator had issued:

> *'Stand Entry Guidance and Aircraft Arrival Procedures, including Marshalling of Aircraft' in an Operational Safety Instruction. This Instruction detailed 'the responsibilities of Airline and Ground Handling staff with regard to the operation of Stand Entry Guidance (SEG), and to advise airside users of the availability of a marshalling service when the SEG is not available.'*

In accordance with the guidance in the Operational Safety Instruction, the airline operator's Standard Operating Procedure (SOP) for TRMs at Heathrow Airport attending aircraft arrivals on stands equipped with an airbridge included the instructions that at:

> *'ETA – 10 minutes' the TRM was to 'ensure stand clear of obstructions/air-bridge correctly parked;' and at 'ETA – 1 minute' the TRM would 'monitor the arrival on stand, TRM positioned by Emergency stop button on ramp.'*

The TRM had been employed in the role since completing her training in March 2006. Since then she had known aircraft to be marshalled on to stands frequently.

Previous event

The operator was the subject of a Safety Recommendation by the AAIB in a report on a previous event in which another of their aircraft was damaged while taxiing on to a stand at Heathrow Airport (see AAIB Bulletin No: 5/2005, reference G-BNLG). The AAIB's Safety Recommendation 2005-020 recommended that the operator:

> 'should require that a member of their ground crew assumes the responsibility of being adjacent to the ground level emergency STOP light button and of monitoring the arrival of the aircraft onto the stand, whenever ground crews are present on a stand whilst an aircraft is manoeuvring to park.'

This is reflected in the SOPs for TRMs at London Heathrow.

Subsequent actions

Since the incident the airline operator has introduced measures to keep TRMs informed of the restrictions on the use of stands and of the relevant aspects of the airport operator's Airside Works programme. This information is conveyed through the airline operator's computer system to which TRMs have access, daily conference calls and the weekly distribution of the airport operator's Airside Works programme within the airline.

The airline has also reiterated to its staff the SOP requirement for TRMs to be positioned next to the emergency STOP light button on a stand while an aircraft is manoeuvring to park.

Discussion

The airport operator had advised the airline operator and the AOSU, in advance, of the work being undertaken on Stand 415 and the fact that the size of aircraft using the stand would be limited during the period specified. Also, they were informed that 'permitted' aircraft would be marshalled on to the stand. This information did not filter down to the TRM or the flight crew on board the aircraft but, within their respective procedures, there were measures that could have prevented the incident.

The flight crew considered the proximity of the airbridge. However, in the absence of any advice to the contrary, the illumination of the SEG system, with the appropriate information, provided them with the necessary clearance to continue to taxi on to the stand. Cautionary advice reminds pilots that 'illumination or activation of any guidance system is not a dependable indication that the stand is clear for use'. It was noted however, as a contributory factor, that it was difficult for the commander to see the aircraft's left wing tip from his position on the flight deck, from where his attention was focussed on the SEG system ahead of him as he taxied forward towards the stop position.

After the TRM had switched on the SEG system, she pursued her concern about the position of the airbridge. Having resolved that a marshaller might be needed, and finding none present on the stand, she and her colleague then took the appropriate actions to stop the aircraft, before it suffered any damage, when it became apparent that the aircraft's left wing tip was about to strike the airbridge. If the SEG system had been disabled for the period that this restriction was in place, the chain of events which led to this incident would have been broken.

The airline operator's subsequent actions have addressed the shortfall in communication which led to the TRM's lack of guidance on the requirement for all 'live' arrivals to be marshalled on to Stand 415. It is considered that the airport operator should implement a policy for disabling the SEG system on any stand which has restrictions placed on its use, to avoid the possibility of similar confusion in the future.

Safety Recommendation 2007-102

It is recommended that the airport operator, Heathrow Airport Limited, should implement a policy to disable the Stand Entry Guidance system on any stand which has restrictions placed on its use.

INCIDENT

Aircraft Type and Registration:	Avro 146-RJ85, OH-SAI
No & Type of Engines:	4 Honeywell LF507 Turbofan engines
Year of Manufacture:	2001
Date & Time (UTC):	17 June 2007 at 1820 hrs
Location:	Stratford St Andrew, Suffolk
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 83
Injuries:	Crew - None Passengers - None
Nature of Damage:	Panel from wing/fuselage fairing detached in flight, minor damage to fin
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	32
Commander's Flying Experience:	5,208 hours (of which 2,688 were on type) Last 90 days - 193 hours Last 28 days - 83 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was inbound to Stansted and descending to below FL200 when a loud bang was heard. A composite panel had become detached from the aircraft and landed on the roof of a house. The panel was attached by 25 bolts which were located inside 25 stainless steel grommets; all 25 grommets had failed. The failure of these grommets was attributed to abrasion during repainting.

There have been several similar incidents and the manufacturer has responded by updating an Airworthiness Directive to include a more rigorous inspection process.

History of the flight

The aircraft was descending to below FL200 whilst inbound to Stansted when a loud bang was heard and the flight crew noticed a change in the airframe noise. The only other change noticed was that the aircraft required slight additional right trim. The descent to Stansted was continued and the flaps and gear deployed slightly earlier than usual to confirm normal operation. The aircraft landed uneventfully.

After parking the aircraft, the crew noticed that a panel was missing from the wing-to-fuselage fairing and there was minor damage to the fin (Figure 1).

The aircraft panel had landed on the roof of a house in the village of Stratford St Andrew in Suffolk causing minor damage to the roof. The panel was recovered by the police; no one was injured as a result of the incident.

Figure 1

Aircraft information

The wing-to-fuselage fairings consist of several composite panels which are attached to the aircraft by a series of regularly spaced bolts. The bolts pass through stainless steel grommets which are permanently fitted into the panels. During manufacture these grommets are inserted into the panels, prior to the grommet flanges being peened over on the upper surface of the panel using a special tool. The resulting grommets provide holes in the panels for the attachment bolts. The thickness of the grommet flanges on the upper surface of the panel is 0.018 inches. The panel that became detached was secured by 25 bolts (through 25 grommets).

When aircraft are repainted it is common practice to strip the metal surfaces. However composite structures, such as the panel that became detached, are usually abraded prior to repainting.

Engineering investigation

The aircraft was inspected at Stansted and the 25 bolts that secure this panel to the aircraft were all still on the aircraft located in their respective grommets (Figure 2 shows an example). The bolts and grommets were then removed and in all cases the grommets were found to have failed (Figure 3 shows several failed grommets). The failure of the grommets differed in detail but the upper flange in all 25 had failed, and there was evidence that the flanges in the region of the failures were of reduced thickness. There was also evidence of paint on the grommet flanges.

The panel that became detached was inspected and there was no evidence of damage to the panel in the region of the 25 holes where the grommets had been.

The similar panel on the right wing to fuselage joint was inspected. The grommets and bolts on this panel had all been painted and it was therefore very difficult to inspect the grommets (Figure 4). Four areas of the right panel in the region of grommets were then stripped of paint and it was determined that the flange thickness on these four grommets was less than specification and importantly, there were marks on the grommets consistent with the flanges having been abraded.

Figure 2

Figure 3

Another aircraft of the same type was inspected and the grommets on a similar panel were all unpainted making inspection much easier.

Previous occurrences

There have been nine broadly similar occurrences of panel attachment problems for this family of aircraft recorded by the manufacturer. Seven of these cases involved overwing panels and in two of these, the overwing panel became detached in flight.

In the majority of these previous occurrences, grommet failure was an issue. The manufacture has issued the following documents relating to this:

a) All Operator Message AOM 05/025V, 30 September 2005 – recommending that operators inspect grommets

b) All Operator Message AOM 06/014V, 13 March 2006 – recommending that operators inspect grommets prior to painting

c) Electronic Service Information Leaflet eSIL 51-146-RJ-413-8, 9 April 2007 – advising operators that Inspection Service Bulletin 53-202 was being written, as well as reinforcing the messages contained in AOM 05/025V and AOM 06/014V

d) Inspection Service Bulletin ISB 53-202 – inspection of grommets and fasteners within 4,000 flights or two years whichever is later. This ISB was the subject of an EASA Airworthiness Directive consultation.

There is also a redesigned grommet which is inserted into the panel from the external side (and not from the internal side of the panel) and this is more tolerant to damage during the paint removal process.

Figure 4

Maintenance activity

In July 2006 the grommets on this aircraft had been inspected in accordance with AOM 05/25V and AOM 06/014V.

This aircraft was fully repainted on 31 March 2007, and it was recorded that the fuselage was stripped and that the composite panels were abraded, prior to painting.

CAP 747: Mandatory Requirements for Airworthiness

The CAA's CAP 747 *'Mandatory Requirements for Airworthiness'* has at Appendix 1 GR10 "Painting of Aircraft" and it notes likely damage and hazards to be avoided, such as reduction of fastener head size during surface preparation.

Analysis

All the retaining bolts were intact and found on the aircraft located in their respective damaged grommets. There was no evidence of the panel having failed in the region of the grommets. It was therefore concluded that the panel became detached because the grommet flanges had failed. The grommet flanges were of reduced thickness, and this is likely to be due to abrading prior to painting given that:

a) there was evidence of abrasion and reduced thickness on a similar panel on the other side of the aircraft

b) the aircraft had been repainted 11 weeks before the incident and this included abrasion of composite panels

This incident reinforces the requirement not to paint the grommets so that effective inspection can be performed.

Manufacturer's response

The manufacturer halted the Inspection Service Bulletin ISB 53-202, which was in the Airworthiness Directive consultation process with the EASA, so they could update it to include paint removal from a sample of grommets prior to grommet inspection. In view of this response no recommendation has been made. This is a known problem that applies to all aircraft types when being repainted.

INCIDENT

Aircraft Type and Registration:	Bombardier CRJ100ER, F-GRJO
No & Type of Engines:	2 General Electric CF34-3A1 turbofan engines
Year of Manufacture:	1999
Date & Time (UTC):	17 January 2007 at 2134 hrs
Location:	Runway 20, Southampton Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 33
Injuries:	Crew - None Passengers - None
Nature of Damage:	None, precautionary removal of nose landing gear for inspection
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	7,500 hours (of which 5,000 were on type) Last 90 days - 150 hours Last 28 days - 40 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft suffered a failure of the No 3 hydraulic system when lowering the landing gear on approach. The commander took what he believed to be the necessary actions prior to landing but without apparent reference to the QRH. As a result the aircraft landed with one of the No 3 hydraulic system pumps still running and the nosewheel steering ON, contrary to instructions in the Quick Reference Handbook (QRH). This resulted in an uncommanded steering input to the right after touchdown and the aircraft departed the runway.

History of the flight

The crew reported for duty at 1625 hrs at Katowice in Poland and had completed an uneventful flight to Paris Charles de Gaulle Airport. At 2039 hrs they departed Paris for Southampton, taking off at 2049 hrs with the co-pilot acting as handling pilot. The takeoff and cruise went without incident and the aircraft was established on the ILS for Runway 20 at Southampton with the autopilot engaged. At a range of about 6.5 nm, with the aircraft descending through 2,000 feet QNH and with 20º of flap set, the co-pilot called for the landing gear to be lowered. The commander selected the gear DOWN and the landing gear lowered with the three green gear indicator lights illuminating.

The pilots reported that almost immediately a 'HYD 3 LO PRESS' caution message appeared on the Engine

Indication Control and Alerting System (EICAS) display 1. The commander selected the hydraulic synoptic page on EICAS display 2 which indicated a loss of hydraulic fluid from No 3 hydraulic system. The commander later stated that he consulted the Quick Reference Handbook (QRH) and identified the appropriate drill (Figure 1). He stated that, as the EICAS indicated there was no fluid remaining in No 3 hydraulic system, he did not switch on the hydraulic 3B pump and was unsure whether he switched off the hydraulic 3A pump, but remembered turning off the nosewheel steering.

The commander lowered the flaps to 30º and later to 45º, the normal landing configuration, and the co-pilot set the approach speed of 137 kt. They then completed the landing checks.

The co-pilot later stated that he disengaged the autopilot at about 500 ft and, late in the approach, positioned the aircraft slightly below the glideslope in an effort to touch down early. The pilots stated the aircraft appeared to touch down normally, on the centreline and in the area of the runway touchdown markings. The co-pilot applied maximum reverse thrust and started to apply the brakes. He stated there appeared to be no asymmetry in the braking or the reverse thrust and the aircraft began to decelerate. The commander recalled that the ground spoilers also deployed normally.

The co-pilot steadily applied more pressure on the brake pedals but felt that the brakes were less effective than normal. He stated that, as the aircraft decelerated below about 70 kt, the speed at which commanders normally take control, it began to veer to the right. The co-pilot released pressure on the right brake and applied full left brake and full left rudder. The commander stated that he also applied full left brake and full left rudder, as well as trying to steer using the tiller. Despite this the aircraft continued to veer to the right, crossing the mouth of Holding Point B1 (Figure 2 - aerial photograph) and departing the runway onto the grass. The pilots estimated the speed to be about 20 kts on leaving the runway, at which point the co-pilot cancelled the reverse thrust, and the aircraft came to a halt.

The commander called the cabin crew member, who confirmed there had been no injuries amongst the passengers. ATC notified the airport fire service; the pilots started the APU and kept the engines running until the fire services arrived and requested they shut down the main engines. The passengers were then disembarked, using the aircraft steps, and were transferred to the terminal by bus.

The crew later stated that, for landing performance, they considered the normal landing distance required for their landing weight of 19,740 kg was no more than about 1,000 m. They stated that they had applied the landing distance correction of 1.5 specified in the QRH to this figure, giving a 'distance required' lower than the landing distance available on Runway 20 "of about 1,800 m". They therefore continued the approach.

Weather

The following weather conditions were recorded at 2120 hrs, 14 minutes prior to the aircraft's landing:

> Wind 210º at 4 kt, visibility in excess of 10 km, FEW cloud at 3,500 feet, temperature 8ºC, dew point 5ºC and QNH 1006.

The weather conditions at 2150 hrs, 16 minutes after the aircraft landed, were:

> Wind 210º at 4 kt, visibility in excess of 10 km, temperature 8º, dew point 5ºC and QNH 1006.

CRJ Series Regional Jet	ABNORM 10-5
	TR RJ/98, Apr 05/07

HYD 3 LO PRESS Msg

NOTE

If during the accomplishment of a hydraulic system low pressure procedure, a second system also fails, disregard both single system failures and proceed directly to the applicable double system failure procedure.

TO PREVENT FLIGHT CONTROL UNDAMPED VIBRATION:	
ALTITUDE LIMITATION	**AIRSPEED LIMITATION**
Do not exceed 31,000 feet	Do not exceed 250 KIAS or 0.55 Mach whichever is lower

(1) HYDRAULIC 3B pump .... ON

(2) Hydraulic pressure and fluid quantity .... MONITOR

System 3 quantity readout is less than 5%, or pressure is less than 1800 psi, or pressure is rapidly decreasing:

Yes

(3) HYDRAULIC 3A and 3B pumps .... OFF

(4) HYDRAULIC page and FLIGHT CONTROLS pages .... REVIEW AFFECTED SYSTEMS

HYDRAULIC SYNOPTIC	
COMPONENT	**SYSTEM 3**
Inboard Brakes (when system 3 accumulator pressure is depleted)	INOPERATIVE
Normal Landing Gear (extension and retraction)	INOPERATIVE
Nosewheel Steering	INOPERATIVE (may result in nose wheel shimmy)
Parking Brake	INOPERATIVE

(5) Land at the nearest suitable airport.

Prior to landing:

(6) N/W STRG .... OFF

(7) LDG GEAR lever .... DN

(8) LANDING GEAR MANUAL RELEASE .... PULL TO FULL EXTENSION

▼

QUICK REFERENCE HANDBOOK CSP A-022	HYDRAULIC SYSTEM MALFUNCTIONS

Figure 1

QRH drill

Figure 2
Holding point B1, Runway 20

Inspection of incident site

The aircraft had stopped in a grassed area 16 m to the right of Runway 20, displaced a distance of 34 m from the runway centreline. From the tyre marks it was determined that both sets of mainwheels, and the nosewheels, had left the runway at the junction with Taxiway Bravo and then entered the grassed area, with the nosewheels having travelling 61 m on the grass.

Figure 2 is an aerial photograph of the location in which the tyre marks are visible. In Figure 3 it can be seen that the marks from the nosewheels are closer to the marks of the right mainwheels than to the marks of the left mainwheels, indicating that the aircraft was 'skidding' slightly to the left. The marks from both the inboard and outboard left mainwheels were consistent with all four brakes functioning normally, and with differential braking to the left. There were heavy scrubbing marks from the two nosewheel tyres, and there was a distinct narrow line outboard of the mark, left by the tread of the left nosewheel tyre, see Figure 4. This line was consistent with the tyre chine (a circular ridge on the outboard side of the tyre designed to deflect water on wet runways) touching the runway.

The torque link, which turns the steerable portion of the nose gear and which is routinely disconnected during towing operations, was found to be connected.

In summary, the evidence from the tyres and ground marks was consistent with the aircraft veering to the right after landing, under the influence of 'nose right' steering of the nose gear, with heavy differential braking of the left mainwheels causing 'scrubbing' of the nosewheel tyres to the right.

Runway state

The runway state at 2120 hrs was described as dry along the full length. The runway surface

Figure 3
Tyre marks, F-GRJO

friction was assessed shortly after the incident. The measured surface friction values were higher than the Maintenance Planning Level[1], and were close to, and in some cases exceeded, the Design Objective Level. It was concluded that runway surface friction was not a factor in this incident.

Flight Recorders

The two solid-state flight recorders were replayed at the AAIB; both had retained a recording of the incident landing and the events immediately preceding it. Whilst recorded radio communications were in English, all conversation between the crew was conducted in French and the Bureau d'Enquetes et d'Analyses (French accident investigation authority) provided an English translation. The co-pilot was the handling pilot for the approach and landing. The commander assisted the co-pilot during the rollout.

Figure 4
Tyre marks - nosewheels

Footnote

[1] As defined in CAA publication CAP 683.

The FDR recorded a number of parameters relevant to this investigation, including the brake 'pressure available' to the inboard and outboard wheel braking systems, together with discrete (ON or OFF) parameters for the presence of low hydraulic pressure on each of the aircraft's three hydraulic systems. Individual wheel brake pressures and data from the nosewheel steering system were not recorded. Pertinent parameters recorded during the approach and landing are shown in Figure 5.

The flight recorders showed that the initial approach was uneventful. At 2,000 ft amsl, with the autopilot engaged and Flap 20 selected, the aircraft intercepted the localiser from the left. It then captured and descended on the glideslope. Shortly after, at 1,830 ft amsl (1,786 ft aal), the landing gear was lowered and the inboard brake pressure available began to reduce from 3,000 psi. Outboard brake pressure available remained close to 3,000 psi. Flap 30 was selected.

Fifteen seconds elapsed before the landing gear indicated that it was locked down. Inboard brake pressure available had reduced to 2,200 psi by that time before beginning to recover slowly towards 2,300 psi. One second after the landing gear indicated 'down and locked' a No 3 hydraulic system low pressure warning was recorded on the FDR, also audible as a warning chime on the CVR. The crew selected the hydraulic page on the EICAS display just before the aircraft was cleared to land and two minutes before the aircraft touched down. The co-pilot commented that they would not have the inboard brakes and that the runway was short. The commander responded that the aircraft was not heavy and then advised the cabin attendant that they would be landing in one minute. The co-pilot further commented that they ought to analyse the situation and asked the commander if he wanted to continue the approach. The commander stated that they would continue.

Flap 45 was selected at 900 ft aal and the crew carried out the 'before landing' checklist. The co-pilot advised the commander that they would have reduced braking and no steering, and asked him if it was not better to divert to London. The commander restated to the co-pilot that they would continue with the landing and request a tow if it became necessary. The autopilot was disconnected at 325 ft aal. The aircraft touched down at 132 kt just to the left of the runway centreline[2] and the ground spoilers deployed symmetrically. The aircraft yawed 1.5° to the left and began to slow; the inner brake pressure available again began to reduce. As the aircraft was derotated and the 'weight-on-wheels' switch for the nose gear was made, the aircraft yawed to the right by 3°. Progressively increasing left rudder was applied which arrested the yaw for a period of about four seconds and reverse thrust was selected. Engine N_1 and reverser deployment parameters showed that maximum symmetrical reverse thrust was used. Six seconds after mainwheel touchdown the co-pilot stated that he had a problem and the commander offered his assistance. Recorded localiser values indicated that the aircraft was heading and tracking to the right of the runway centreline and towards the right side of the runway at that stage. Seven seconds after touchdown, with airspeed and inner brake pressure available having reduced to 97 kt and 2,000 psi respectively, the aircraft briefly yawed 2° to the left before, with full left rudder now being applied, yawing progressively to the right at a rate of 2.7º per second.

From the changes in recorded values of pitch attitude and normal acceleration, it is likely that the nose gear left the paved surface at an airspeed of about 50 kt whilst

Footnote

[2] Derived from the recording of localiser deviation.

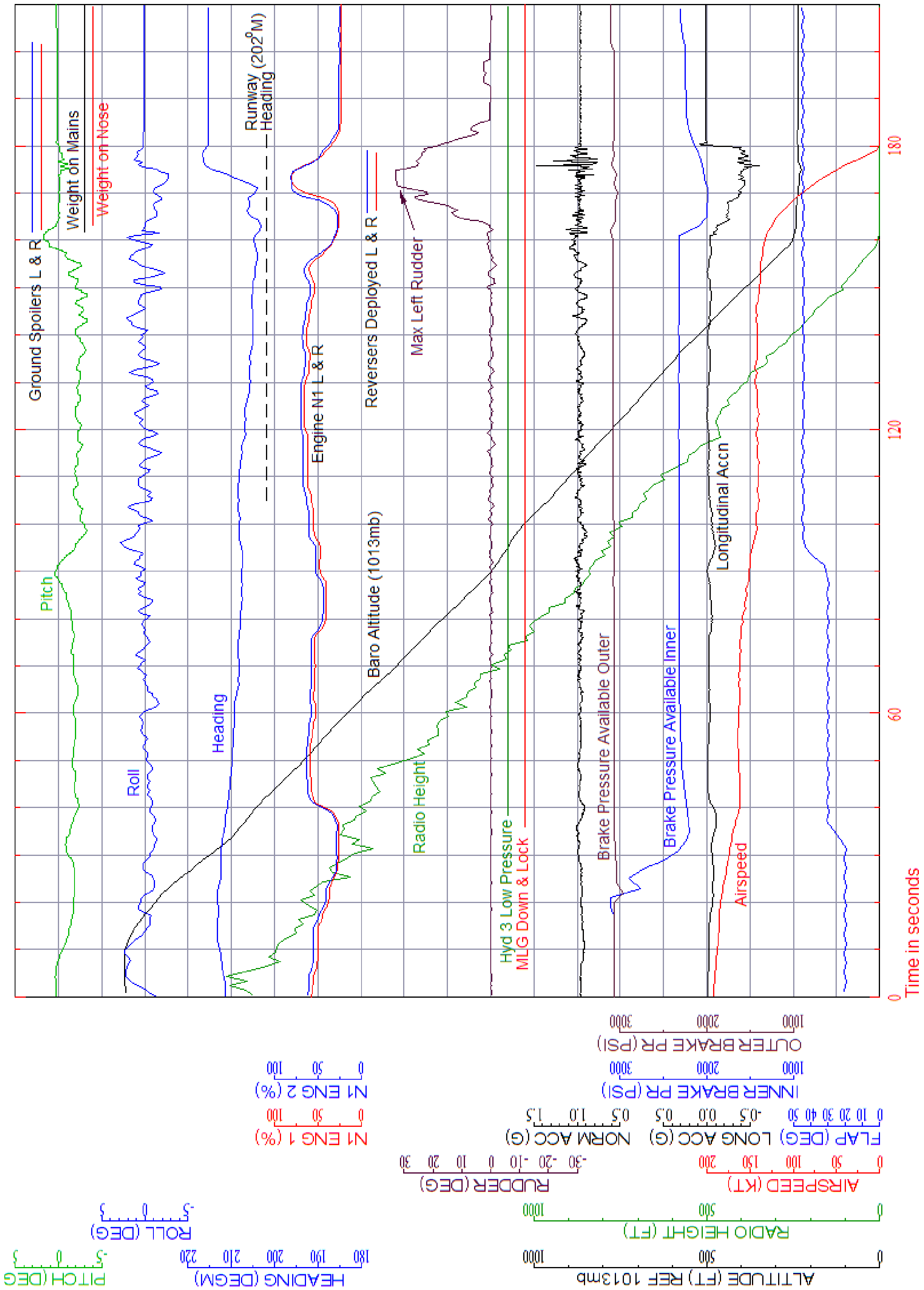

Figure 5

FDR plot, F-GRJO

the main gear followed one second later. The aircraft came to a halt on a heading of 215°M, 19 seconds after main gear touchdown. The crew advised ATC that they had had a hydraulic problem and had been unable to maintain good braking action, but that there was no fire.

The CVR showed that, during the discussions immediately after the aircraft had come to a halt, the crew debated whether they should have aborted the landing. They also referenced the checklist appropriate to a No 3 hydraulic system low pressure warning. With regard to the status of the No 3 hydraulic system, the commander commented that "*OFF OR NOT, IT DIDN'T CHANGE ANYTHING*".[3] The co-pilot then requested "*STEERING OFF, YOU CAN PUT IT OFF*". The sound of a switch selection was then recorded before the commander replied "*OFF, SO I DID NOT PUT IT...*" Further checklist discussion centred around the factoring of an increase in landing distance by 50% and advice to brake carefully and use maximum reverse thrust.

Throughout the landing roll the recorded values of longitudinal acceleration showed that the aircraft was being slowed effectively. However, in the absence of actual recorded brake pressures, it was not possible to determine whether any degradation in the inner braking system had occurred as a result of the reduced inner brake pressure available.

Aircraft information

The Bombardier CRJ is a twin-engined, 50-seat regional airliner, and over 1,000 have been built (all variants).

The main forces that decelerate the aircraft after landing are spoilers which dump lift and act as airbrakes, thrust reversers and four anti-skid brakes, one mounted on each of the four mainwheels.

Footnote

[3] English translation provided by the BEA.

There are 3 hydraulic systems on this aircraft type. The No 3 hydraulic system has two electrically-operated pumps to provide power, pump 3A and pump 3B, and these are installed in the left and right wing-to-fuselage fairings respectively. A schematic of the hydraulic system is shown in Figure 6. From this it can be seen that the only hydraulic power supply for the nose gear door, the nose gear steering, and the landing gear retraction is from No 3 hydraulic system. The inboard brakes (both left and right) are also supplied from No 3 system. Figure 6 shows that the outboard brakes are powered by No 2 hydraulic system, and the inboard brakes by No 3 hydraulic system.

Both the outboard and inboard brakes have a hydraulic accumulator. If either No 2 or No 3 hydraulic system fails, then the brakes on the failed system can be applied four or five times before the accumulator is depleted. Therefore, in the case of a failure to No 2 or No 3 hydraulic system, one set of brakes will operate normally, the other (on the failed system) will operate satisfactorily but only for four or five applications on the brake pedals, and thereafter this set of brakes will be ineffective.

There are selector switches for the hydraulic pumps on the overhead panel in the cockpit, as in Figure 7. The normal operating position for all four switches is down: Pump 1 AUTO, Pump 3A ON, Pump 3B AUTO, and Pump 2 AUTO.

Directional control on the landing roll is maintained by a combination of rudder, asymmetric brakes and nosewheel steering. The nosewheels can be turned to 70° to the left or right by using the handwheel control unit situated to the left of the left pilot's seat, or to approximately 8° to the left or right by application of the rudder pedals. It is normal operating practice for the handwheel to be used at speeds of less than 70 kt .

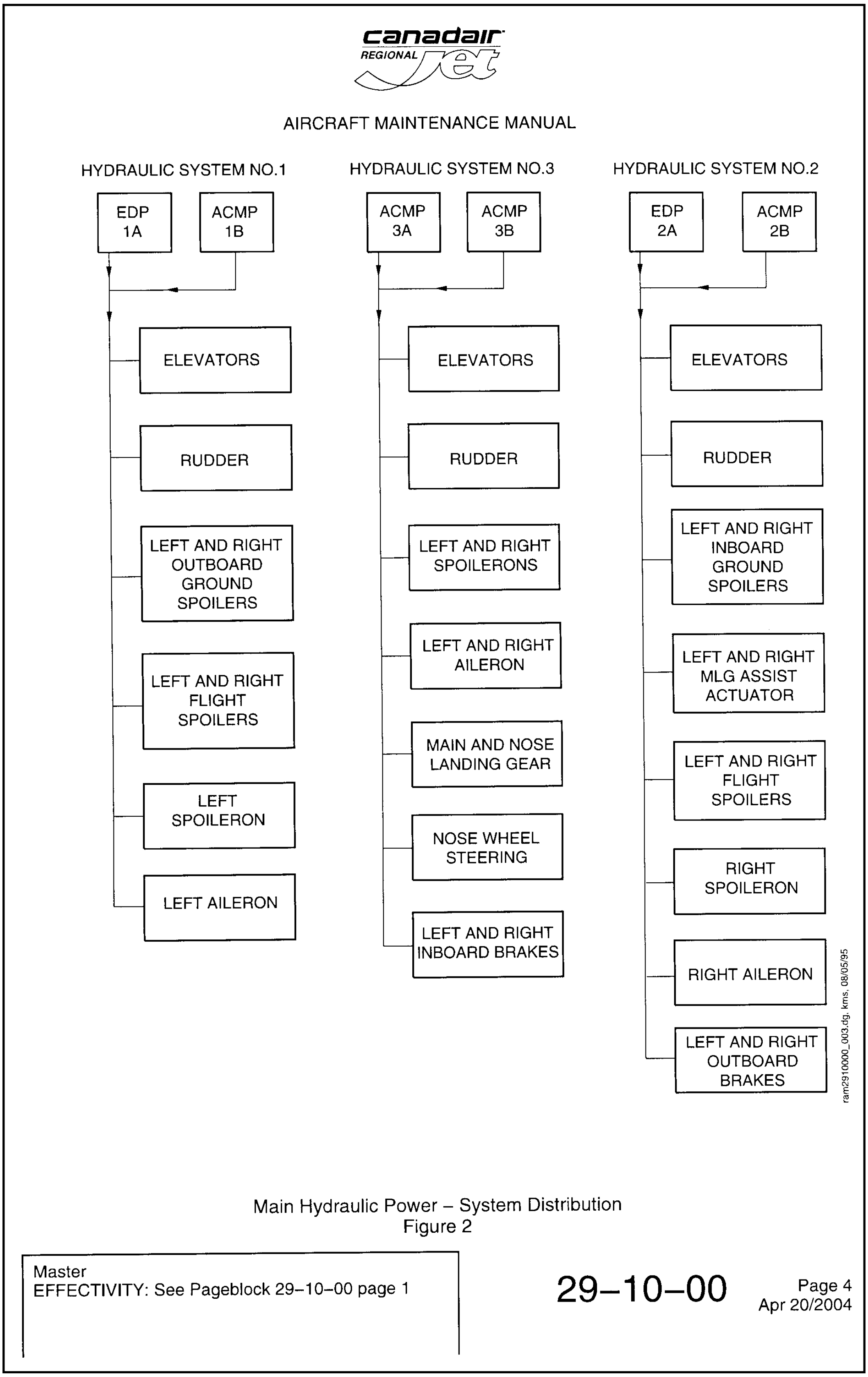

Figure 6

Hydraulic system schematic

Figure 7

Overhead panel

The CRJ has a 'steer-by-wire' Nose Wheel Steering (NWS) system. The NWS system is electrically controlled and hydraulically powered (Figure 8). If the NWS is switched off, or if the NWS Electronic Control Unit (ECU) detects a fault, the system reverts to a free-castering mode. In this mode, valves isolate the hydraulic pressure in the two steering actuators and these actuators act as dampers; the nosewheels are then free to caster. The normal hydraulic pressure is 3,000 psi. With the NWS armed, the system operates normally for No 3 system hydraulic pressures between 1,650 and 3,000 psi, and reverts to free-castering mode at a pressure below 600 psi. For pressures between 600 and 1,650 psi (with the NWS armed) the system's performance may be reduced.

Engine Indication Control and Alerting System (EICAS)

The EICAS display consists of two screens situated on the central flight deck console, which provide information to the crew on the status of the aircraft and are the means by which warning, caution and advisory messages are displayed. The system does not provide information on actions that might need to be taken by the crew should such messages appear, this information being contained in a Quick Reference Handbook (QRH).

Aircraft inspection

Following this incident at Southampton, the aircraft was inspected:

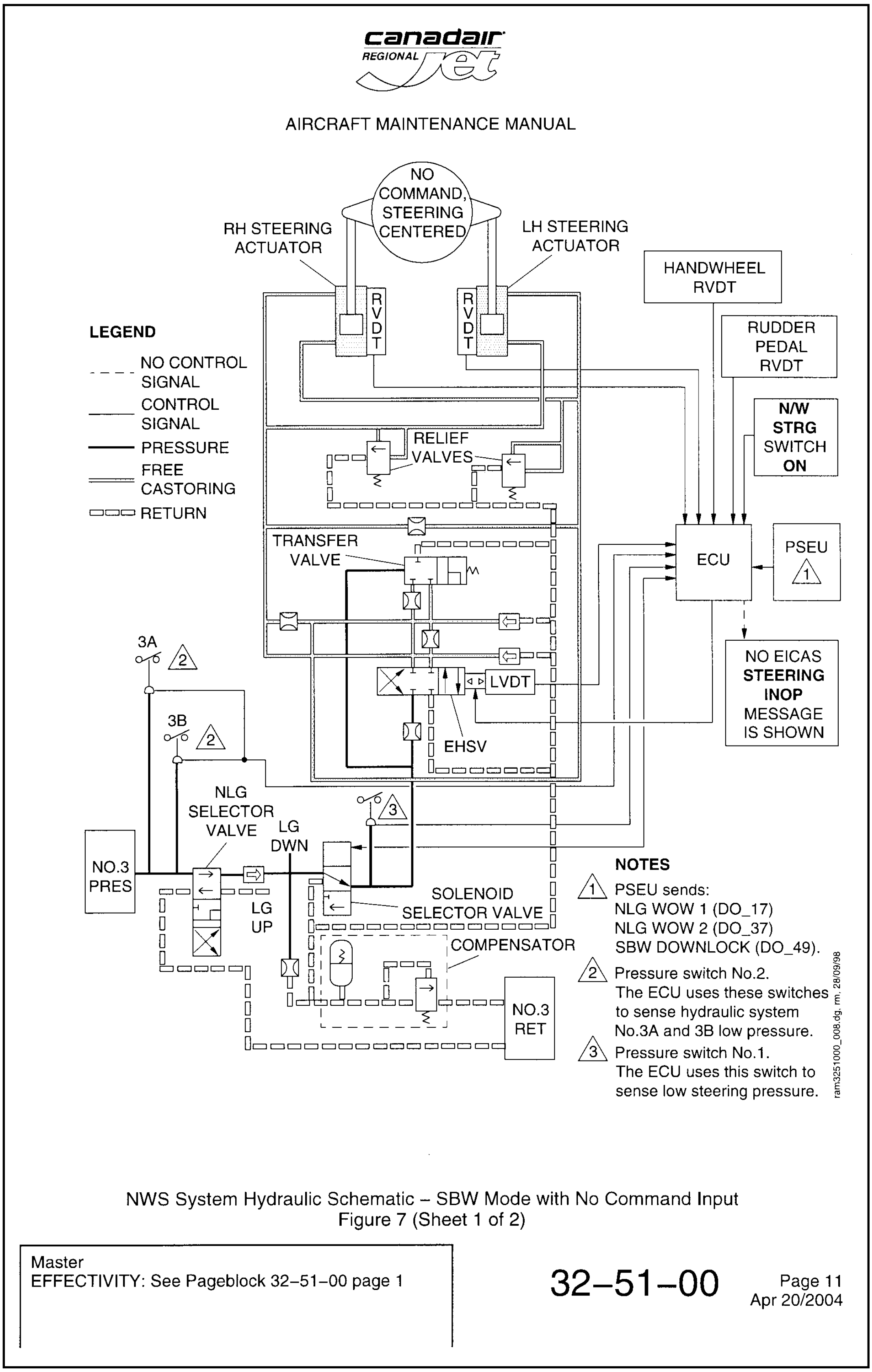

Figure 8

NWS schematic

a. The left nosewheel tyre was found to have regular transverse marks at approximately 12° to the wheel axis, and the tyre chine, which usually shows no signs of wear, had signs of heavy loading, see Figures 9 and 10. The orientation of the marks is consistent with both nosewheel tyres being highly loaded and 'scrubbed' to the right, opposing the aircraft's motion. There were no significant marks on the chine on the right nose tyre.

b. The nose gear leg and associated structure was inspected and no damage was seen.

c. With the aircraft on jacks the nose gear steering system was functioned and the rigging values were checked, with nothing abnormal being

Figure 9 (left)
Tyre chine, left nosewheel

Figure 10 (right)
Tyre tread, left nosewheel

found. The free-castering mode was checked, firstly with the hydraulics ON (at the normal 3,000 psi) and the steering OFF, and secondly with the steering ON and the hydraulics OFF. In both cases the upper link could be rotated by hand, indicating that the nose gear system has reverted to free-castering mode as expected.

d. There was a leak at the outlet of hydraulic pump 3A at the elbow joint. An 'O' ring had ruptured and the failure appeared consistent with a rapid loss of fluid. A locking wire was missing between the pump and the elbow fitting and either this, or the incorrect installation of the 'O' ring, appeared to be the cause of the failure.

e. There was a leak at the flexible outlet hose on pump 3B. This leak was confirmed by raising the system pressure until a leak was detected, with a slow and constant loss of fluid. No loose fittings or damage could be found, although the locking wire between the pump and elbow fitting was missing (as on pump 3A). The short length of outlet hose was aligned in a gentle 'S' shape, and this may have induced extra, and unnecessary, tension in the installation.

f. Apart from heavy contamination of mud and grass, nothing abnormal was found with the tyres and brakes on both main gears.

g. The fans and intakes of both engines were found contaminated by mud. More detailed inspection revealed no damage to either compressor, and subsequent engine runs confirmed that the performance of the engines was not significantly degraded.

Further engineering investigation - nosewheel steering

Most of the components of the nose gear steering system, including the nose leg and the steering Electronic Control Unit, were removed from the aircraft for further examination. The components were inspected individually and used to recreate on a rig, as far as practicable, the nose gear steering system that was on F-GRJO.

The individual inspections of the components revealed nothing significant. However, the rig test revealed that, if the pressure was between 650 and 1,650 psi when the 'weight-on-wheels' switch was activated, then the nosewheel steered slowly to the right at a rate of about 1° per second. The torque was typically 3,000 lbf-in, which is almost an order of magnitude less that that for normal operation. Above 1,650 psi the steering system would steer normally; below 650 psi the system went into free-castering mode. The drift required that the steering system be switched ON, and for hydraulic power to be provided, effectively requiring either pump 3A or 3B (or both) to be ON. Such a drift would occur for all aircraft with this NWS system, the direction of the drift depending on the particular aircraft.

The 3A and 3B hydraulic pumps were sent for inspection. There were no significant defects and no signs of overheating.

Various design cases for the nosewheel steering were discussed with the nose gear manufacturer. This included an assessment of how much steering torque was available for a given hydraulic system pressure, as well as how much torque would be required for a given nosewheel angle. The discussion concluded that, with hydraulic pressures in the range of 650 to 1,650 psi, there was sufficient torque to steer the nosewheel to at least 4°.

Further engineering investigation - hydraulic leaks

The Maintenance Manual was reviewed with the manufacturer and the operator. The review concluded that the wording in the procedures for installation and removal of the hydraulic pump could be improved to ensure that pumps are correctly installed and fittings correctly wirelocked. The operator noted that, as a result of their internal investigation, they issued an internal technical bulletin to cover 'O' ring installation, hydraulic pump wirelocking and installation of hydraulic hoses. For their part, the manufacturer made minor changes in the maintenance manual.

Further engineering investigation - possibility of adverse rudder effectiveness

The aircraft manufacturer considered the possibility that the jet efflux from the thrust reversers, passing over a rudder surface fully deflected to the left, had an effect on aircraft directional control. They concluded that there was a possibility of some reduction in rudder effectiveness at lower airspeeds but not of a reversal of the rudder's control effect. To support this, the manufacturer referred to wind tunnel and 'on-aircraft' tests conducted in 1994 and 1995.

Analysis

During this investigation, rig testing clearly demonstrated a scenario in which the nosewheels would slowly steer in one direction without any command input. For this to occur, the pressure in the No 3 hydraulic system needed to be in the range of 650 to 1,650 psi, and the Nose Wheel Steering to be ON, with the 'weight-on-wheels' switch activated after the nosewheel touchdown. The pressure could be in this range after a hydraulic leak and with one, or both, of the No 3 system pumps being ON. Importantly, this particular nose gear steered to the right, which agreed with the direction the aircraft veered, the tyre marks on the runway, and damage to the left nose gear tyre chine.

The commander recalled referring to the QRH. He believed he had not switched on the hydraulic 3B pump and was unsure if he had switched off the hydraulic 3A pump. He also believed he had turned OFF the nosewheel steering.

Evidence from the CVR indicated that no reference was made by the crew to the QRH whilst airborne. It provided evidence that the Nose Wheel Steering was in the ON position for the approach, that it was not switched OFF whilst airborne, in response to the hydraulic failure, and that it remained ON for the ground roll. In addition, the CVR provided evidence that the switches for the hydraulic pumps 3A and 3B remained in the ON and AUTO positions respectively throughout the approach and ground roll.

The QRH drill (Figure 1) would, in this case, have required that the hydraulic 3A pump, the hydraulic 3B pump and the nosewheel steering all be switched OFF. In addition it required the re-calculation of the landing distance required. Comments by the co-pilot that they should divert to London suggest he was concerned about the landing distance available. Whilst there was, in fact, sufficient landing distance available, the CVR gave no indication that such a calculation was carried out by the crew prior to landing.

The crew became alerted to the hydraulic failure at a late stage in the approach, a little over two minutes prior to touchdown. It is likely that the commander believed he had sufficient knowledge of the system, reinforced by the information provided to him by the EICAS, to be able to continue the landing safely without having to action the items in the QRH.

Whilst this incident would not have occurred had the QRH been followed (ie the NWS and hydraulic pumps 3A and 3B had been switched off) there remains the possibility that, in another case, a hydraulic failure could occur just before touchdown. In such a case it would be unreasonable to expect a crew to take the appropriate actions quickly enough to prevent a similar lack of controllability on the ground. The following Safety Recommendation is therefore made:

Safety Recommendation 2007-101

It is recommended that Bombardier Aerospace review this design of nose gear steering system, in the CRJ100 and other company products, to prevent uncommanded nose gear steering following a hydraulic failure.

INCIDENT

Aircraft Type and Registration:	Dassault Falcon 20-F5, N757CX
No & Type of Engines:	2 Honeywell TFE-731-SER turbofan engines
Year of Manufacture:	1980
Date & Time (UTC):	9 May 2007 at 2205 hrs
Location:	Descent and approach to London (Stansted) Airport
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - 5
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	7,622 hours (of which 2,053 were on type) Last 90 days - 109 hours Last 28 days - 34 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was descending towards London (Stansted) having flown from Gander, Canada, when a lateral flight control restriction became apparent. Full force by the pilots was applied to both control wheels in an attempt to recover lateral control, but no movement was possible. The aircraft was landed safely at London (Stansted) by means of the elevator and rudder controls. During the investigation, a significant volume of water was discovered below the floor panels in the forward fuselage; the water had frozen in flight and caused a restriction to the movement of the aileron trim actuator.

History of the flight

The flight originated in Little Rock, Arkansas, USA. Both members of the flight crew were commercial pilots who flew the aircraft regularly; one of the passengers was also qualified to fly the aircraft. The two pilots reported for the flight at 1000 hrs (0500 hrs local time).

The first sector was from Little Rock to Teterboro Airport, New Jersey and was uneventful: the aircraft was then on the ground for 41 minutes. The passenger qualified to fly the aircraft was the handling pilot during the second sector, from Teterboro to Gander, Canada. During the approach to Gander, whilst flying manually, he noticed that the lateral flight controls were unusually stiff and commented on this to one of the commercial pilots; this pilot was the aircraft commander during the subsequent flight to Stansted. He noticed that the aileron trim position indicator was positioned at about 1/8 to 1/4 of maximum deflection. He centred the trim and the handling pilot reported that the lateral control was now better. At this stage, the commercial pilot assumed that the reason for the stiffness was that the ailerons had been mis-trimmed. The aircraft landed uneventfully and was on the ground at Gander for 39 minutes.

The third sector, from Gander to Stansted, was operated by the two commercial pilots; the commander occupied the left hand seat and was the handling pilot. The flight control check before flight was normal. After about two hours at cruise altitude, with the autopilot engaged, the pilots noticed a flickering aileron TRIM caption on the Primary Flying Display (PFD) (see 'Autopilot description'). The commander applied corrective trim, in the required direction, but the caption re-appeared from time to time. The commander disconnected the autopilot and found that the roll control felt stiffer than was normal; he then re-engaged the autopilot and continued the flight. Several times the aircraft started to drift off the required track; the commander used the aileron trim to adjust the tracking. The non-handling pilot consulted the Emergency/Abnormal procedures checklist to see if there was any guidance on a lateral flight control problem. There was no specific procedure available, but under the heading 'ABNORMAL RESISTANCE OF FLIGHT CONTROLS' there was the information:

> *'Do not hesitate to apply extra force in an attempt to overcome abnormal resistance during the movement of a flight control.'*

On the descent towards Stansted, whilst attempting to follow radar vectors, the commander found that the lateral flight control problem had become worse. The autopilot turned the aircraft to the left normally when required but the aircraft was reluctant to return to wings level flight. Then, whilst in a left turn, the bank angle continued to increase, and when it reached around 45º the commander disconnected the autopilot with the intention of flying manually. He found that the roll control was very stiff when rolling to the right and he used the rudder to bring the aircraft to a wings level attitude. Both pilots now applied force to the control wheel but were unable to move it. The control wheel was central but the aileron trim indication was now indicating 2 units (1/2 of maximum deflection) to the right.

The commander was only able to make turns through the gentle use of rudder, accordingly he restricted the bank angle to a maximum of 10º. The pilots advised ATC that they had a jammed flight control and were not able to do turns to the right and were only able to make shallow left turns. ATC responded by asking the pilots if they were declaring an emergency; the reply was "YES SIR". ATC provided vectors requiring left turns only until the aircraft was in a position from which it could intercept the localiser and establish on the ILS approach for Runway 23 (See Figure 1).

The weather conditions at London Stansted featured strong gusting winds from a westerly direction, with a cloudbase at around 2,000 ft. The commander was able to intercept and maintain the ILS course by using the rudder. He was concerned, however, that in the turbulent crosswind conditions he might have some difficulty were the aircraft to roll whilst close to the ground during the landing. The surface wind prior to touchdown was from 240º at 16 kt with a maximum of 25 kt. A successful landing was made at 2222 hrs and the aircraft came to a stop on the runway. The pilots confirmed to ATC that they did not require any assistance and were able to taxi to a parking area.

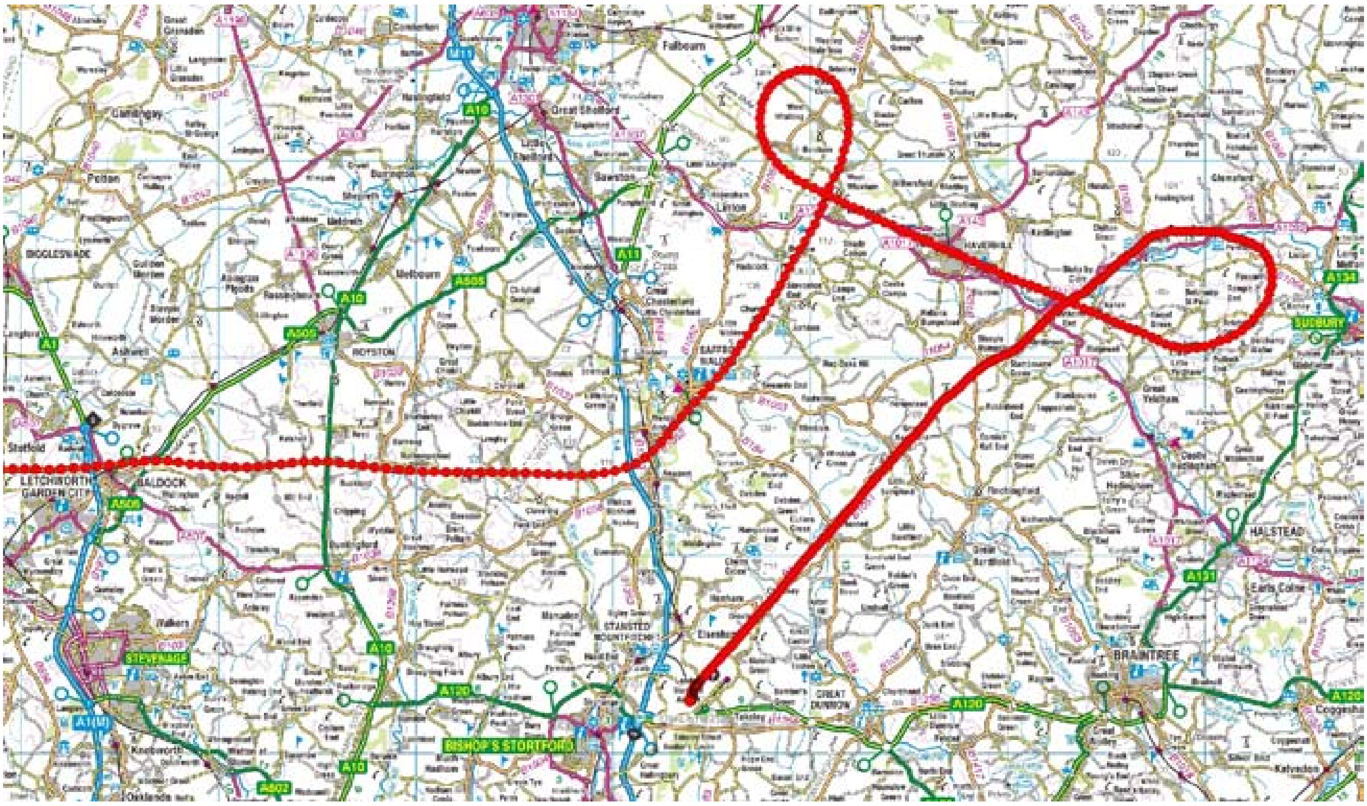

Figure 1

Radar track of N757CX inbound to London Stansted

Some 20 minutes after the aircraft had been shut down the control wheel was still jammed. The non-handling pilot carried out an external inspection of the aircraft and found that he could not move the ailerons either. The pilots left the aircraft parked and retired to their accommodation.

Aircraft information

History of the aircraft

N757CX (serial number 408) was originally built in 1980 with General Electric CF-700 engines and conventional cockpit instrument displays. Later, it was fitted with Honeywell TFE-331 engines and a 'glass' cockpit display. In December 2006 it was flown to a maintenance company for a 'C' check which was followed by a repaint and retrim; this exercise took approximately ten weeks. It had been back in service for about six weeks at the time of the incident, and in that time had flown approximately 20 hours.

The aircraft was normally based at Little Rock Airport, Arkansas, and operated principally on flights within the USA. The flight times recorded on the day of the incident were:

Little Rock to Teterboro	2 hrs 30 mins
Teterboro to Gander	2 hrs 12 mins
Gander to Stansted	4 hrs 42 mins

Description of the roll control circuit

The Falcon 20 aircraft has dual hydraulic systems with manual reversion of the primary flight controls available in the event of a double hydraulic failure (see Figure 2). From the base of the control columns, rods and bellcranks

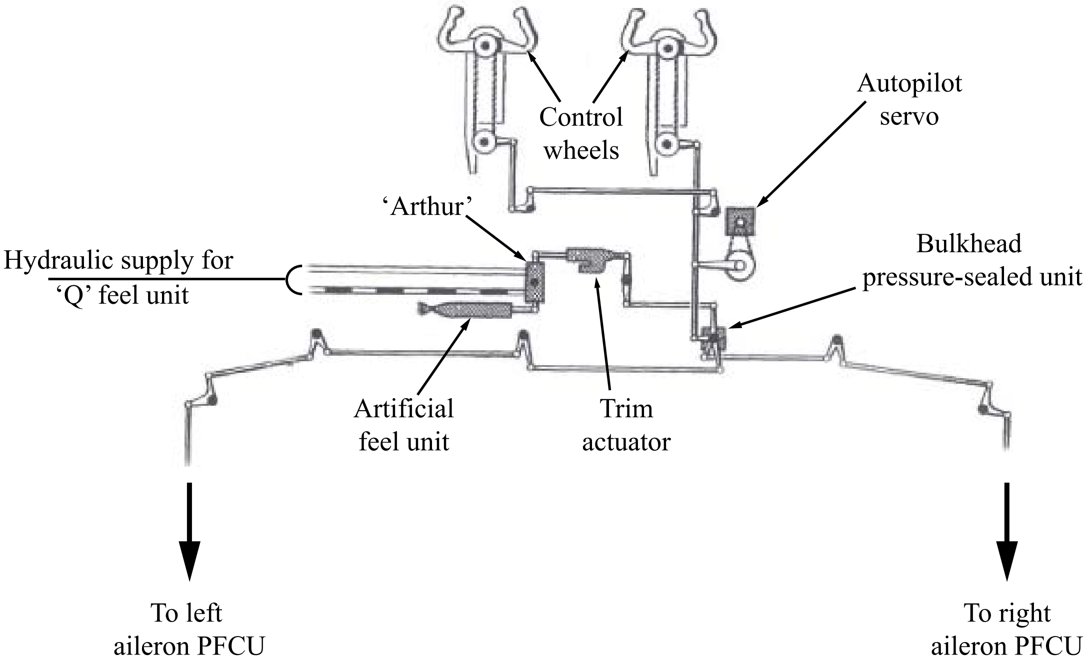

Figure 2

Schematic of Falcon 20 aileron mechanical control system

are used to transmit yoke inputs to the hydraulic servos in the wings. The autopilot actuators for roll and pitch control are situated on the right side of the forward vestibule, above the main floor level, from whence the roll control rod goes down to below floor level. A pressure-sealed bulkhead unit then allows rods to travel outside the pressure hull to the left and right wings. However, a further rod remains in the pressurised area to connect to the electric roll trim actuator, the hydraulic 'Q' feel unit (called 'Arthur' by the manufacturer) and an artificial feel unit, which is a simple spring strut and serves the purpose of centring the control. Thus it can be seen that the aileron trim actuator body moves with pilot or autopilot inputs and that, when trim commands are made, the actuator effectively extends or retracts against the artificial feel unit spring, deflecting the ailerons. It should be noted, therefore, that if movement of the electric trim actuator body, which moves with control inputs, is restricted, then that restriction will be felt by the pilots or the autopilot.

Moreover, the roll trim actuator is situated low down at the rear of the forward fuselage (Figure 3) and it can be seen that the underside of the actuator body is only a few centimetres above the lowest point of the belly skins.

Autopilot system

The autopilot controls the ailerons through a servo motor which is connected to the control wheel linkage; there is an engage/disengage clutch mechanism which can be manually overridden by the pilots in case of a failure of the clutch to disengage. The autopilot has a similar arrangement for pitch control. If the aileron trim requirement changes, the autopilot holds the load until it becomes excessive, at which point an aileron mis-trim warning is generated. This warning is displayed on the PFDs: a yellow 'A' indicates a moderate aileron mis-trim (around 3.7 lb) and a flashing red 'A' indicates a significant aileron mis-trim (around 7.4 lb). A left or right pointing arrow is displayed below the warning; there is no additional indication. To correct the mis-trim

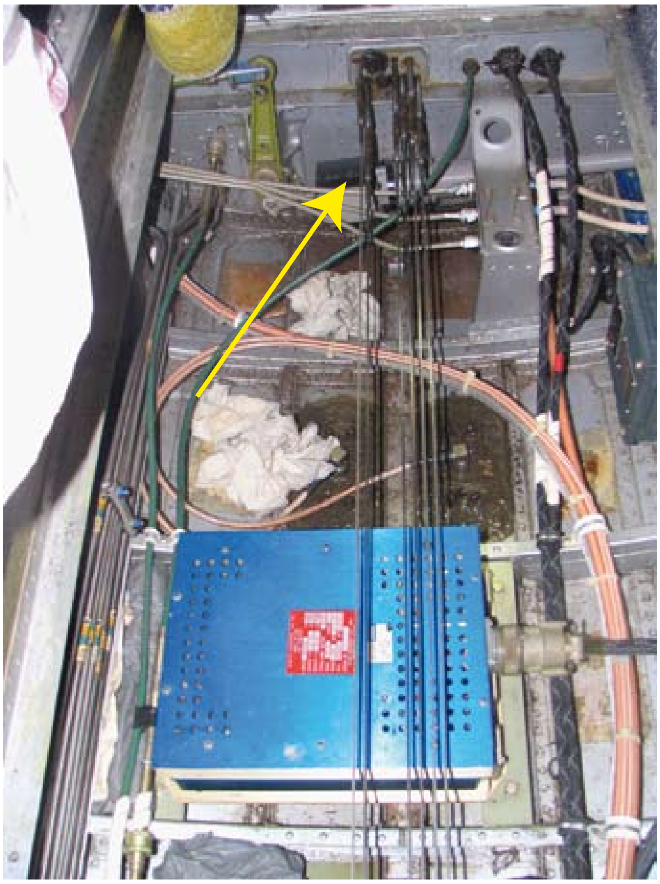

Figure 3

View of lower fuselage skin of N757CX with floor panels removed. Note the location of aileron trim actuator (arrowed)

the pilot applies trim in the appropriate sense, by means of a pair of electric trim switches located on the centre pedestal, until the warning disappears. The aileron trim gauge is marked as a percentage of full aileron deflection (which is +/-15º); the maximum position indicated on the trim gauge is 40%, which equates to +/-6º of aileron deflection, therefore, 2 dots, or half scale, represents 3º of aileron deflection. Normally, when an away-from-neutral trim setting exists, the control wheel will also be displaced from the neutral position, but for small trim commands the amount of deflection is minimal. The autopilot will not disconnect when the load becomes excessive because, were it to do so from a severe out-of-trim condition, the aircraft would roll rapidly.

Fuselage drains

The aircraft is fitted with seven underbelly drains in the forward fuselage of a type which the manufacturer calls 'manual (semi-automatic)'. Most of the drains are located towards the nose but one drain is located just forward of the wing front spar.

The Airplane Flight Manual pre-flight checklist, carried on-board the aircraft, did not contain any reference to the fuselage drains. The drain outlets are flush with the underside of the fuselage and should be marked with a black or coloured circle. This aircraft had recently been repainted and there were no such markings associated with the drains.

Examination of the aircraft

The aircraft was examined about 36 hours after landing. In addition to the AAIB Inspectors, present at the examination were the flight crew, two representatives from the company that had completed the major maintenance and, later, a representative of the aircraft's manufacturer.

It was immediately apparent that the ailerons were free to move without hydraulic power and felt normal when exercised throughout their full range using the control yokes; with hydraulic power applied the control check was also normal. Inspection of the control runs in the wings and above the floor showed no anomalies and the pressure-sealed bulkhead unit, inspected from outside, also appeared normal. The autopilot actuator functioned correctly, with no tendency for the clutch to remain engaged.

It was then decided to lift the central floor panels to gain access to the roll trim actuator and the associated mechanisms underneath. It became immediately apparent that there was a large quantity of water contained in the belly of the forward fuselage of the aircraft, but, as a hand was dipped into the water in the area of the manual drain, the drain opened and water started to pour out onto the ground at a considerable rate. Unfortunately, there was no container available to catch such an unexpectedly large amount to measure its quantity, and only a sample could be taken: it was also not possible to close the drain until a suitable container could be found.

However, the water continued to flow at a high rate for in excess of ten minutes and it is estimated that at least 20 litres of water was drained from the aircraft. After drying out the area and discarding soaked insulation, the interior was reassembled and the aircraft conducted a lengthy test flight at altitude to ascertain whether the problem had been resolved. There was no recurrence of the lateral flight control symptoms and the aircraft later departed with passengers for its base in the United States. During these legs, and subsequently, there have been no further reports of control restrictions.

The manufacturer has received notification of three previous events similar in nature to that experienced on this flight. These were reported to the European Aviation Safety Agency by means of a 'Significant Event Report' following the incident involving N757CX.

Information from the flight crew

The pilots were interviewed on the day after the flight and the history of flight is largely compiled from their account. Both pilots were experienced on the aircraft type and had flown this particular aircraft frequently. They were also aware that it had recently returned from a scheduled maintenance check. The pilots said that an occasional aileron trim caption was not an unusual event during a flight. They advised that there had been no notable turbulence en-route and the weather was clear throughout all the sectors until the descent in UK airspace. They also reported that the fuel had remained in balance throughout the flight and that the aircraft had about 1,400 lbs of fuel on board during the approach to Stansted.

After the water had been discovered in the fuselage and the keel drain had been found to have been stuck, the crew were asked about their use of fuselage drains. They commented that they routinely checked that the galley drain was working after a flight but that checking of the keel drain was a maintenance function which would have been done before the aircraft was released for flight. The commander believed that he had seen the galley drain working after arrival at Gander.

Recorded flight information

Flight recorders

The aircraft was not required, under the applicable regulations, to be fitted with either a Flight Data Recorder or Cockpit Voice Recorder (CVR). However, a CVR was fitted which recorded the last 30 minutes of flight crew speech and cockpit area microphone sounds before electrical power was removed from the aircraft.

The CVR recordings started just as the crew were given clearance to land, with the aircraft six miles from Stansted. Once the aircraft was on the ground the crew discussed how the "AILERONS WERE COMPLETELY FROZEN – WE HAD NO AILERONS", which prompted the (qualified) passenger to remark "THAT'S WHAT HAPPENED TO US GOING INTO GANDER", referring to the previous sector when he had experienced similar problems whilst manually flying the aircraft during the approach to Gander.

Radar recordings

Radar data for the flight, detected by the Stansted primary radar and secondary surveillance radar, was recorded by the London Area Control Centre.

The recorded data started at 21:50:00 with N757CX overhead Royal Leamington Spa on a south-westerly track whilst descending through Flight level 204. A left turn was then made, as the aircraft passed over Brackley, onto an easterly track. Figure 1 depicts the aircraft on this easterly track overhead Letchworth (21:58:53) at Flight Level 117 (still descending) and ends with the landing and subsequent taxiing at London Stansted (22:26:14). The figure shows several 270° turns to the left, followed by minor heading corrections to the right as the aircraft was positioned to intercept the localiser on the ILS approach to Runway 23.

Analysis

There appears little doubt that the large quantity of water drained from the belly of the forward fuselage was responsible for the initial 'heavy' feel, and subsequent freezing, of the lateral flight controls. Even if the water level did not actually touch the trim actuator with the aircraft on the ground (bearing in mind that the precise quantity was not established before it drained away), the typical cruise attitude of about 4° nose-up would allow the water to migrate and increase the level around the actuator. Restricted movement of the actuator body would then result in corresponding restriction of the ailerons: entrapment by ice would also explain why the (literally) frozen aileron condition which persisted after landing was not replicated when inspected by the AAIB when mild temperatures had allowed the ice to melt over a period of some 36 hours.

The aircraft normally carried out internal flights in the USA; this particular flight was fairly unusual in that it was over a long distance and consisted of a series of sectors with short turnaround times. The effect of the time at altitude would have been to expose any water trapped in the fuselage to cold temperatures. The flight sectors were broken by only short periods of warmer temperatures when the aircraft was at low level or on the ground. During the approach into Gander some degree of freezing of the fuselage water seems to have occurred which restricted the trim actuator movement.

After the departure from Gander the already cold water would have again been exposed to very cold temperatures and progressively froze. The transatlantic flight would have involved few changes in direction so the trim actuator body would have remained largely undisturbed, except when the pilots applied trim. Eventually the trim actuator body would have become completely frozen and trapped, so that later on even the pilots' combined efforts on the control wheel could not move it.

Once the trim actuator body had started to freeze, the autopilot would have had difficulty in moving the ailerons. Therefore, the roll control was, in effect, being achieved through the pilot's use of the electric trim. The amount of roll control available through this means is limited. As the aircraft speed reduced during the descent and approach the aileron control deflection required to maintain or change the heading would have become greater. Thus, the inability of the aircraft to respond and achieve the demanded heading would have become more noticeable. Ultimately the aircraft continued to roll to the left until the commander intervened and disconnected the autopilot. He was unable to roll the aircraft to wings level and had to use the rudder to assist. Both pilots then applied their full combined force to their control wheels but were unable to move them because, by this time, the trim actuator body was trapped. Thereafter, by necessity, all the turns were made using the rudder.

The commander reported that the control wheel had jammed in a wings level position with the aileron trim indicating 2 units. However, since trim position is derived from extension of the trim actuator, the indication could have been misleading – if the actuator body had been firmly trapped by ice in the neutral position, trim commands would simply compress or extend the artificial feel spring without physically moving the control surfaces although indicating some deflection on the trim position indicator.

The source of the water is problematic. The sample appeared relatively clear, fresh and without odour, so is highly unlikely that it originated before, or during, the major inspection which the aircraft had recently undergone. There are no potable or other water supplies in the related area; the only possible source was a drain from the icebox, which is normally replenished before each flight. This drain closes under pressurisation but opens on the ground to allow water from the melted ice to drain away. Not only was this drain found to work normally, but there were no leaks identified in the tubing between it and the icebox.

Water in aircraft bilges can come from a variety of sources: leaking plumbing, condensation and leaking door seals are the most common. The amount of water found would seem to preclude condensation as the capacity of the ice drawer was not sufficient for the water to have accumulated during the course of one or two flights. Therefore, it seems likely that the water must have built up in the fuselage over a period of time. Forensic analysis of the water sample concluded that it was most probably rainwater, rather than condensate or tap water, which would imply that either the aircraft had a leaking door seal on the ground, or that the door had been left open during rain. The quantity would seem to suggest either a long exposure time, or torrential rain, or both. However, the manufacturer believes that a more likely source of the water in question was minor leaks in the area of the icebox drain occurring over an extended period of time; this concurs with the views of the operating crew.

Safety action

In the days following the incident, the aircraft manufacturer issued a communication to operators which included the information:

'OPERATOR COMMUNIQUÉ - URGENT - No. 050721-1 Subject: Jammed aileron control during descent'

Dassault reminds Operators that drains must be checked during the aircraft daily inspection as described in the Operating Manual daily servicing in the "DRAINING OF CONDENSATION WATER" sub-chapter. This check is also part of the Basic Inspection every 7 days and part of the A inspection. The content of the "DRAINING OF CONDENSATION WATER" section of the daily servicing and Basic Inspection is under consideration in order to see if it can be improved. In the meantime, as a precaution, Dassault recommends that Operators check both manual (also called semi-automatic) drains and automatic drains during the above referenced maintenance operations.'

The Communication also reminded operators that the drains must be marked by a coloured circle.

It is considered that the action taken by the manufacturer should be sufficient to prevent a re-occurrence. Therefore, no safety recommendations have been made as a result of this investigation.

INCIDENT

Aircraft Type and Registration:	AS332 L2 Super Puma, G-REDO
No & Type of Engines:	2 Turbomeca Makila 1A2 turboshaft engines
Year of Manufacture:	2005
Date & Time (UTC):	3 September 2007 at 1530 hrs
Location:	Offshore in the Sumburgh area, Shetland Islands
Type of Flight:	Aerial Work
Persons on Board:	Crew - 4 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Winch cable failure during casualty recovery
Commander's Licence:	Air Transport Pilot's Licence
Commander's Age:	N/A
Commander's Flying Experience:	N/A hours (of which n/k were on type) Last 90 days - N/A Last 28 days - N/A
Information Source:	Accident report form submitted by thewinchman and examination of cable by the AAIB

Synopsis

Whilst attempting to recover a casualty from a fishing boat, the primary winch cable parted, leaving the casualty and the winchman on the vessel's deck. Examination showed that the cable had been subject to mechanical damage in the region of its failure and that the majority of the cable strands had failed as a direct result of this damage. It is possible that the cable became damaged when the swell moved the fishing vessel from under the helicopter causing the cable to lay across its bow.

History of the flight

The crew had been tasked to recover a casualty from a fishing vessel. On arrival over the vessel, the helicopter entered a hover at 50 ft and lowered the winchman to the deck using the primary winch, to conduct an assessment of the casualty; the winch cable was retracted whilst the winchman was onboard the vessel. After completion of the assessment, the casualty was moved to the bow of the vessel for recovery. The primary winch cable was lowered again and the helicopter manoeuvred back over the deck, which allowed the winchman to connect the casualty and himself to the cable. As he gave the signal to be winched up, the swell moved the vessel from under the helicopter, which required the winch operator to pay-out more cable and the helicopter to be repositioned, before attempting the lift. The winch operator stated that during this period, the winch cable was seen to lie across the bow of the fishing vessel but that it did not appear to snag on any equipment or fittings; no tension was reportedly felt by the helicopter crew on the cable. Immediately the cable became vertical, the winch was operated. The cable failed approximately one metre from the hook as load was applied, leaving the winchman and the casualty on the deck. The cable was reeled in and secured, before a successful recovery of the winchman and casualty was made using the secondary winch.

The helicopter winch operator stated that, although the fishing boat was pitching and rolling, it was considered within the limits for a normal vertical lift.

Investigation

The broken cable was subsequently removed from the helicopter and sent to the AAIB for examination. Microscopic visual inspection showed clear evidence of mechanical damage to a large number of the cable strands close to the failure, which included scoring and cutting, see Figure 1.

The majority of these strands had failed in the region of this damage, with fracture surfaces characteristic of relatively brittle tensile failure. The remaining strands, approximately 15% of the total, exhibited fracture surfaces associated with a degree of plastic deformation (necking) prior to failure in tensile overload. All of the fracture surfaces were free from corrosion and there was no evidence of prior cracking or fatigue.

Conclusions

The nature of the cable failure indicated that the primary cause was due to mechanical damage to the majority of the strands, possibly occasioned when the cable laid across the vessel's bow.

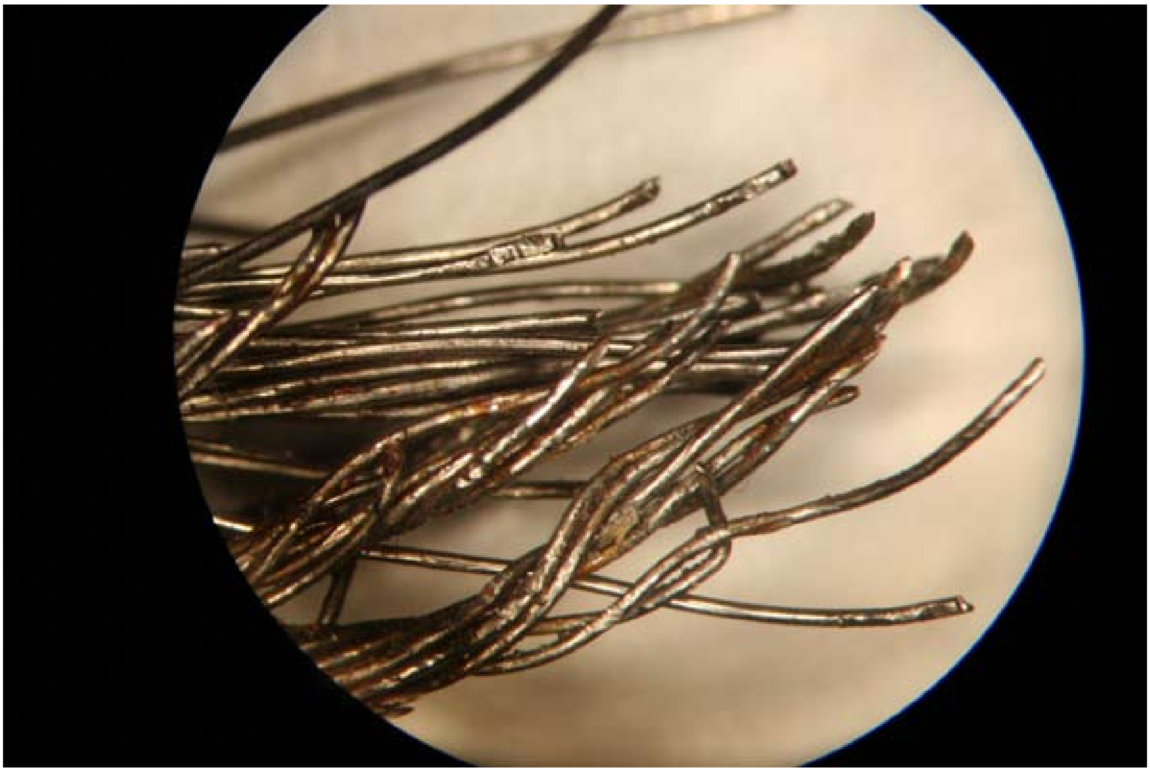

Figure 1

Failed cable strand ends mostly exhibiting evidence of mechanical damage at or close to the failures

ACCIDENT

Aircraft Type and Registration:	Aero AT-3 R100, G-SPAT
No & Type of Engines:	1 Rotax 912-S2 piston engine
Year of Manufacture:	2003
Date & Time (UTC):	29 November 2007 at 1315 hrs
Location:	Elstree Aerodrome, Hertfordshire
Type of Flight:	Private
Persons on Board:	Crew 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller and spinner, engine cowling and exhaust, both wing leading edges and upper surfaces and left side of fuselage. Damage to PA28 G-AZDE; right fuselage side, cargo door and right flap
Commander's Licence:	Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	188 hours (of which 23 were on type) Last 90 days - 16 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On start-up, the aircraft began to move and struck a parked aircraft.

History of the flight

The aircraft had been parked at Elstree, adjacent to a Piper PA-28R-200 G-AZDE, for approximately 30 minutes following a short flight from North Weald. The pilot carried out the pre-flight checks and started the engine. The aircraft immediately started to move forward turning to the left. The pilot attempted to shut down the engine but was unable to do so before the aircraft swung round and struck the adjacent aircraft, causing damage to the right hand side of its fuselage.

The pilot concluded that when he parked the aircraft, and applied the hydraulically operated main-wheel brakes, he may have inadvertently pressed the left pedal more than the right. The park brake is applied by a switch that is connected to a valve which maintains the hydraulic pressure in the brake system, thus keeping the brakes applied. There is no braking effect from operating the pedals while the park brake is applied. The pilot also noted that the engine rpm at start-up was higher than normal which further exacerbated the situation. He tested the brakes after the accident and found them to be serviceable.

ACCIDENT

Aircraft Type and Registration:	Pioneer 300, G-CEEG
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2006
Date & Time (UTC):	9 June 2007 at 1431 hrs
Location:	Oban Airport, Strathclyde, Scotland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Broken propeller, slight damage to engine cowling, landing gear jacks buckled
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	1,450 hours (of which 90 were on type) Last 90 days - 87 hours Last 28 days - 32 hours
Information Source:	AAIB Field Investigation

Synopsis

The landing gear seized in the partially extended position and during the subsequent landing, the nose gear collapsed allowing the propeller to make contact with the runway.

History of the flight

On the day of the accident the pilot flew the aircraft from his private strip to Bute where he made an uneventful landing. The aircraft then departed for Oban and during the subsequent pre-landing checks the pilot lowered the landing gear and noted that the green indicator light had not illuminated and the landing gear Circuit Breaker (CB) had tripped. The pilot reset the CB and the blue indicator light briefly flashed before the CB tripped again. He selected the landing gear UP and reset the CB, but once again the blue flashing light briefly illuminated before the CB tripped. The pilot attempted to reset the CB six times before attempting to manually lower the landing gear using the emergency crank handle; however, the winding handle would not move in either direction. Through the inspection window the pilot could see that that the nose landing gear appeared to be in the DOWN position. He therefore informed Oban Radio of the problem and his intention to land. When the pilot selected full flap, a red warning light illuminated and a buzzer operated. The landing appeared to be normal until the end of the landing run, when the right landing gear partially collapsed, quickly followed by the collapse of the nose landing gear. This allowed the propeller to strike the ground.

Description of the landing gear

The aircraft is equipped with an electrically operated, retractable, tricycle landing gear. The landing gear electric motor is connected to a gearbox by a belt drive. The gearbox turns three screw jacks, each of which is connected to one of the landing gear leg operating mechanisms. As the screw jacks extend, the operating mechanisms move into the over-centre position, which then locks the landing gear legs in the DOWN position. The system is equipped with microswitches, which isolate the electrical power to the motor when the landing gear legs reach their fully extended or retracted position. The pilot can manually lower the landing gear by the use of an emergency crank handle that can be connected directly into the gearbox. An inspection window in the floor of the cockpit allows the pilot to see the position of the nose landing gear.

The system also contains three cockpit warning lights. A green light illuminates when the 'gear down' microswitch operates and a flashing blue light illuminates when the landing gear moves between the up and down positions. A red warning light and buzzer will operate if the flaps are selected down and the down-lock microswitch has not operated.

The electrical power supply for the landing gear motor and the green and blue indicator lights is protected by circuit breaker CB3. However, the electrical power for the red warning light and buzzer is via a different circuit breaker, CB8. Therefore if CB3 trips, the landing gear motor and the blue and green indicator lights will not operate. However the red warning light and buzzer will still operate and warn the pilot if he selects the flaps fully down without the landing gear being locked in the DOWN position.

Inspection of the aircraft

Photographs taken after the landing and before the aircraft was removed from the runway show that the nose landing gear had collapsed, the right main landing gear was partially retracted and the left main landing gear appeared to be in the extended position. Marks on the runway indicated that the nose landing gear collapsed whilst the aircraft was still moving forwards.

The owner of the aircraft, who was also the pilot on the incident flight, reported that the right main landing gear screw jack and nose leg locking rod had buckled, which had caused the nose and right landing gear to collapse. The owner removed the right landing gear screw jack and retraction mechanism and attempted to rotate the right main leg about the retraction spindle (see Figure 1). However the leg could not be easily rotated about the spindle and remained jammed at an angle of approximately 50°.

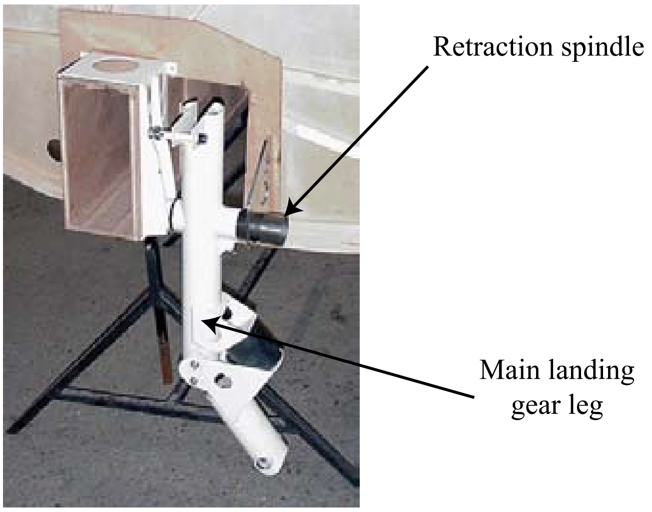

Figure 1
Main landing gear leg

On removing the right leg from the retraction spindle, the owner noticed that there was paint on the inner portion of the spindle and that there did not appear to be much grease on the painted portion of the shaft (see Figure 2). There should not be any paint on the spindle.

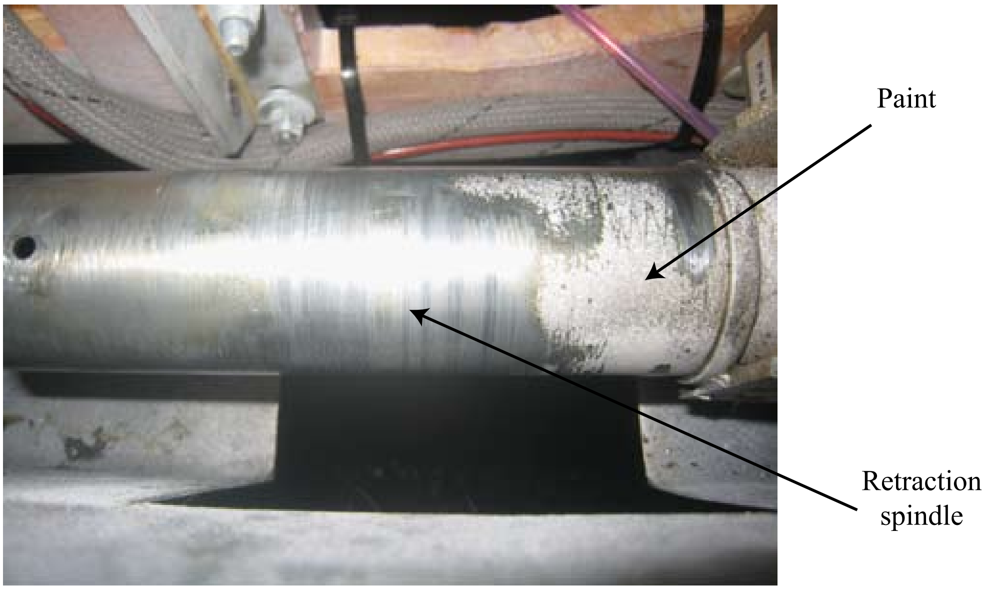

Figure 2
Paint on right spindle

There was no paint on the spindle for the left leg. The owner was of the opinion that the paint might have left insufficient space to allow the grease, which is applied via a nipple on the landing gear leg, to flow along the full length of the right spindle. Consequently he believed that it was the accumulation of the paint debris, as it was rubbed off the spindle, and a partially dry bearing face that caused the leg to seize on the spindle. The owner reported that the leg rotated freely after the paint had been cleaned from the right spindle, though he did comment that when grease was applied through the grease nipple, surplus grease was only seen to come out of the outside edge of the spindle. Following the replacement of all three screw jacks and the nose leg locking rod, the landing gear was cycled satisfactorily using the original gearbox and electrical motor.

Use of circuit breakers

Aircraft CBs are designed to trip (become open circuit) in order to protect the wiring, connectors and electrical components from the effects of excess heat following a serious electrical event. One example was an airborne fire on a Cessna 172, G-BHDZ[1], which occurred as a direct result of the pilot resetting the CB for the alternator. As the repeated resetting of CBs could result in an aircraft fire, a number of major aircraft manufacturers advise that they should only be reset once and then only if the system is essential for the safe operation of the aircraft. The Civil Aviation Authority also gives general advice in Civil Air Publication (CAP) 562 on the resetting of CBs in flight.

'In-flight operational use of CBs will usually involve the action of resetting a circuit breaker which has tripped because of an electrical overload or fault. Clearly the reestablishment of electrical power to a circuit which is at fault does involve, however slight, an element of risk. Accordingly, flight crews should be advised not to attempt to reset CBs in flight for other than essential services and, even then, only when there is no clearly associated condition of smoke or fumes. A second reset should not be attempted.'

Footnote

1 AAIB report published in Bulletin 7/2007.

As with other sport aviation aircraft, there was no guidance in the aircraft flight manual for this aircraft regarding the resetting of CBs. With the increasing introduction of electrical and electronic equipment on to sport aviation aircraft, both the British Microlight Aircraft Association and the Popular Flying Association have stated that, as a result of this accident, they intend to raise the awareness of the dangers of resetting CBs with their members. Whilst the CAA publishes general advice on the resetting of CBs in CAP 562, General Aviation (GA) pilots might not be aware of the dangers in repeatedly resetting CBs, even those protecting lower power circuits, in flight. In order to ensure that the various GA communities are made aware of these dangers, the following Safety Recommendation is made:

Safety Recommendation 2007-113

It is recommended that the Civil Aviation Authority take appropriate action to increase awareness, in the various General Aviation communities, of the risks involved in resetting circuit breakers in flight.

Comment

The aircraft had been painted 86 flying hours prior to the accident, shortly before delivery to the owner. The landing gear had been greased approximately 20 hours prior to the accident by the owner, and the microswitches had also been adjusted, but no other relevant maintenance had been carried out. The UK importer stated that the landing gear legs had been fitted to the spindles before the aircraft had been spray painted and, therefore, the paint could not have been applied to the spindle at that time. The UK importer also stated that he was unaware of any occasions when the leg had seized on to the spindle and was of the opinion that the single grease nipple was sufficient to ensure the correct lubrication of the bearing face.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BLWP
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978
Date & Time (UTC):	11 October 2007 at 1013 hrs
Location:	Hawarden Airfield, near Chester
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nosewheel collapsed, damage to propeller and engine
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	887 hours (of which 467 were on type) Last 90 days - 50 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The student pilot mis-judged the landing flare. The aircraft 'ballooned' and landed heavily before the instructor could take control, resulting in a collapse of the nose undercarriage leg.

Accident details

The aircraft was engaged on a circuit training detail, flying from Runway 04 at Hawarden with an instructor and his student on board. The 76 year old student pilot, who was handling the aircraft when the accident occurred, had in excess of 70 hours flying and had last flown 10 days before the accident flight. Although judged to be capable of a good standard of handling, his performance was considered to be somewhat inconsistent, and he had yet to fly the aircraft solo. The majority of his flying had been done at a previous flying school, having moved to the school concerned in late 2006.

The weather conditions were suitable for the exercise, with a light and variable surface wind. The approach to the runway was stable, and the instructor noted that the aircraft was only very slightly fast as it crossed the threshold. As the student pilot flared the aircraft for landing, it 'ballooned'. This had also happened on the previous landing and, as the student pilot had corrected that situation with use of power, the instructor did not immediately take control. However, the student did not take the correct action on this occasion, and the aircraft landed heavily before the instructor could intervene.

After a very short landing roll, the nose undercarriage leg failed. The instructor shut the engine down, but not before the propeller had struck the runway, causing further damage to the propeller, engine and cowlings. The aircraft came to rest upright on the runway, and the two occupants vacated by the left and right doors. They had been wearing lap straps with diagonal shoulder harnesses, and were uninjured.

ACCIDENT

Aircraft Type and Registration:	Rans S6-ESD XL (Modified), G-MZDA
No & Type of Engines:	1 Rotax 582 piston engine
Year of Manufacture:	1995
Date & Time (UTC):	29 May 2007 at 1348 hrs
Location:	Carlisle Airport, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller and hub detached from gearbox, superficial damage to nose cowling
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	80 years
Commander's Flying Experience:	602 hours (of which approximately 500 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries

Synopsis

At about 400 to 500 ft agl the propeller became detached from the aircraft. The pilot made a 180° turn and was able to land successfully on the reciprocal runway. Two 'half-rings' that retain the propeller shaft inside the gear box were found to have failed and the manufacturer is currently undertaking a detailed examination of these components.

History of the flight

The aircraft had taken off from Runway 25 without incident and was climbing normally at approximately 500 ft/min. At about 400 to 500 ft agl the propeller, including the hub, spinner and shaft, became detached, and the engine speed rapidly increased.

The pilot lowered the nose, set the speed to 60 mph, and made a 180° turn to the right and headed for the reciprocal runway, Runway 07. He then made a 'MAYDAY' call and the controller advised that the runway was clear for him to land. The aircraft was successfully landed on Runway 07, and the pilot considered that since the wind was 300º at 10 kt, his decision to turn to the right helped to ensure that the aircraft was able to land on the runway.

The propeller and hub fell into a field near a private house. No one was injured in the accident. A student pilot on his way to the airfield and who had seen the propeller become detached, recovered the propeller and hub.

Aircraft information

The Rotax 582 is a two-stroke engine and this unit was fitted with a reduction gearbox (see Figure 1). The propeller shaft, item 16 on Figure 1, rotates in two bearings in the gearbox and is retained by two half-rings that sit in an annular groove in the shaft; these half-rings are housed inside an annular collar. The half-rings are known to wear and as a result require replacing during maintenance.

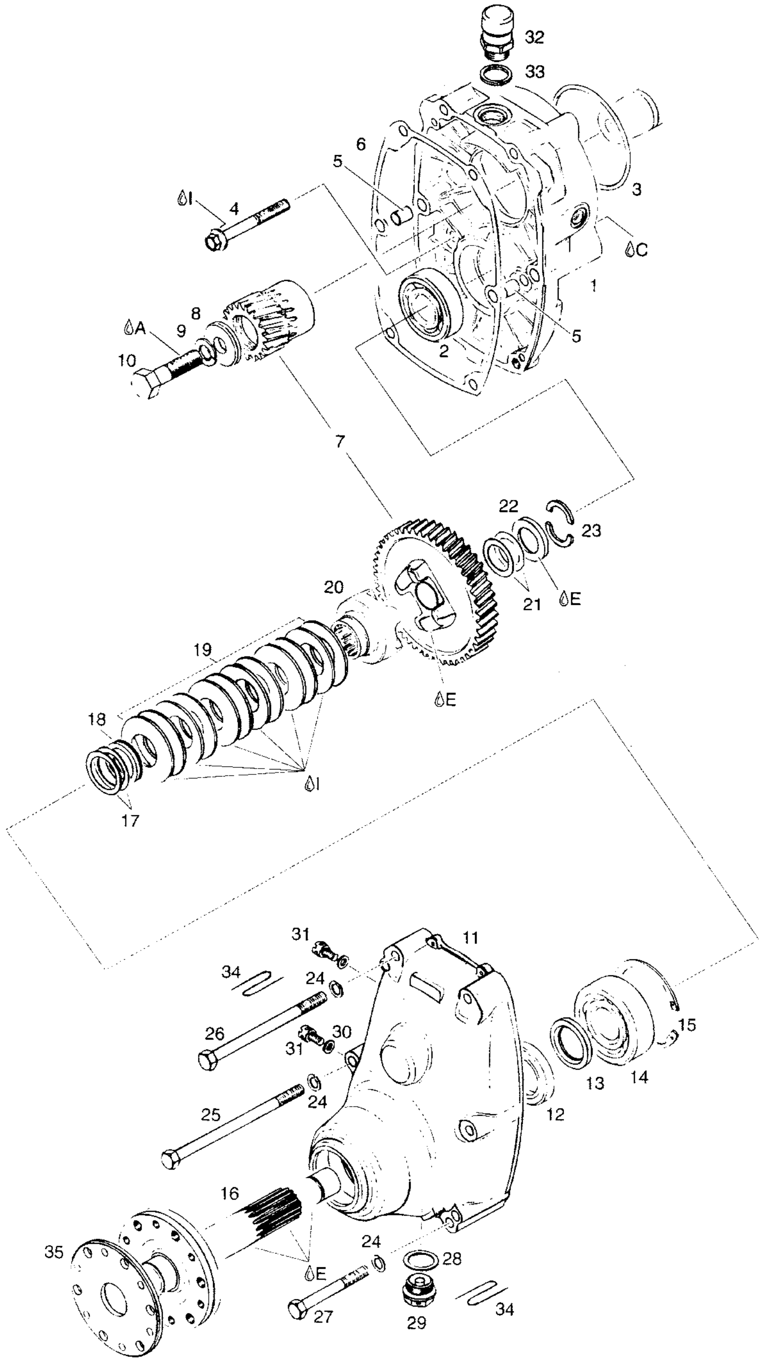

Figure 1

The engine had completed 600 hours and the gearbox had completed 27 hours since being overhauled. During the overhaul, which was undertaken by an engineer experienced with this type of engine, the half rings had been replaced.

Engineering investigation

The propeller shaft and the gearbox components were sent to the AAIB, and subsequently to a metallurgist for examination. The components that failed are shown in Figures 2 and 3; note that the collar had broken into two pieces, and that each of the half-rings had broken into two pieces.

The metallurgist concluded that there were high cycle fatigue fractures in the collar and both the half-rings. There was, however, no evidence of wear on the half-rings.

The parts were sent to the UK service agent for the engine who reported that, whilst they had seen failures of the split rings before, they had never seen such a failure within 30 hours of gearbox overhaul. Moreover, they had never seen a failure of the annular collar.

The components have been sent to the manufacturer for further examination.

Discussion

The half-rings had recently been replaced by an experienced engineer and hence incorrect installation would seem unlikely. This would appear to be an unusual failure and hence the components have been sent to the manufacturer for further analysis. This may take some time. Should further significant and relevant information be obtained by AAIB, a supplementary report will be published.

Figure 2
Half rings

Figure 3
Collar

ACCIDENT

Aircraft Type and Registration:	Rutan Long-Ez, G-BNCZ
No & Type of Engines:	1 Lycoming O-235-C2C piston engine
Year of Manufacture:	1988
Date & Time (UTC):	1 September 2007 at 0924 hrs
Location:	Turweston Aerodrome, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Main landing gear detached and propeller damaged, lower fuselage, engine cowling and right wing tip scraped
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	8,000 hours (of which 10 were on type) Last 90 days - 140 hours Last 28 days - 60 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB telephone enquiries.

Synopsis

The canopy opened when the aircraft took off. The pilot landed ahead firmly and the main landing gear detached as a result.

History of the flight

The pilot reported that on rotating the aircraft during the takeoff run, the side-hinged canopy became unlatched, and that once the aircraft became airborne, the canopy opened fully. The pilot was concerned that it might then detach and strike the rear mounted pusher propeller so he therefore decided to land ahead on the remaining runway length. A firm landing took place, resulting in detachment of the main landing gear. The aircraft veered to the right, stopping after running on to the grass.

The pilot stated that the cockpit can become very hot in summer if the aircraft is taxiied with the canopy shut. It is thus sometimes necessary to delay closing it until very shortly before takeoff. He considered that this contributed to his failure to ensure the canopy was fully latched before he began the takeoff roll. Once airspeed was gained, the canopy profile caused lift to be generated, allowing the insecure canopy to open.

ACCIDENT

Aircraft Type and Registration:	Spezio DAL-1, G-NOBI
No & Type of Engines:	1 Continental Motors C125-2 piston engine
Year of Manufacture:	1970
Date & Time (UTC):	21 April 2007 at 1300 hrs
Location:	Nayland Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Damage to landing gear, lower fuselage and both wing leading edges
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	400 hours Last 90 days - Not known Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries

Synopsis

During the approach, the engine started to run roughly and the aircraft failed to reach the airfield. In the subsequent final approach for the forced landing, the pilot reported the speed becoming too low, and the elevator response being less than expected as he commenced the flare. The aircraft landed heavily, and in doing so the landing gear became detached and the pilot suffered a severe compression fracture to a vertebra, which required hospitalisation.

Whilst not conclusive, the most likely reason for the rough running of the engine was the continued selection of carburettor heat during the approach. This, combined with the engine mixture being set to rich, probably caused the engine to run excessively rich and, to eventually, to run roughly. The pilot's lack of experience on type was considered a factor in the subsequent forced landing.

History of the flight

This was the pilot's first solo flight in this aircraft type. The takeoff and flight up to the first approach had been uneventful, and the pilot reported selecting carburettor heat as required and without incident. He then made an approach to Runway 32, which he subsequently rejected because he felt that the approach was too fast and too flat.

The engine responded normally to the pilot's full-throttle input and the aircraft climbed and commenced another circuit. When the aircraft was on the down wind leg, and with the carburettor heat on, the engine was throttled back. It then started to run roughly and some dark smoke started coming out of the cowling. The pilot applied full throttle but the engine did not respond normally and the aircraft failed to climb. The pilot now doubted that he could land on Runway 32, which has power cables just before the threshold. He was also concerned that the smoke indicated an engine fire. He elected to land in a large field that was short of Runway 32 and he therefore made a turn of approximately 90° to the left. Prior to landing he switched off the fuel and magnetos. In the subsequent final approach to the field, the pilot reported the speed became too low, and the elevator response was less than expected as he commenced the flare. The aircraft landed heavily, and in doing so the landing gear became detached. The harness remained secure; however the pilot suffered a severe compression fracture to a vertebra which required hospitalisation. Subsequent examination of the aircraft showed that there was no evidence of a fire, either in flight or after the forced landing.

Aircraft information

The Spezio DAL-1 is a single-engined, home-built aircraft and G-NOBI was fitted with a Continental C125-2 engine. It is a two-seat, low-wing monoplane with two cockpits arranged in tandem and with a tail-wheel landing gear, see Figure 1. As a result of the tandem cockpit layout it is sometime referred to as the 'Spezio Tuholer'. The aircraft has conventional primary flying controls but does not have flaps. Flight controls were fitted in both cockpits although the fuel management controls were only fitted to the rear cockpit.

Figure 1

Photograph of G-NOBI
(reproduced with permission of Tom Cole)

Airfield information

Nayland has two grass runways: Runway 14/32 and Runway 13/31. The gradient of the field is such that it is common practice for aircraft to take off on Runway 13 or 14, and to land on Runway 32, the latter having a steep upslope.

Meteorological information – possibility of carburettor icing

The Met Office supplied an aftercast for the airfield at the time of the accident and this included the information contained in Table 1 below.

It can be seen that there was a tailwind component on Runway 32.

By reference to a standard chart for carburettor icing, the temperature, dew point and humidity were such that carburettor icing at glide power was possible.

Discussion

Since the pilot had the carburettor heat selected for the circuit, and it remained selected when he opened the throttle, it is unlikely that carburettor icing was a problem.

Whilst not conclusive, the most likely reason for the rough running of the engine was the continued selection of carburettor heat during the approach. This, combined with the engine mixture being set to rich, probably caused the engine to run excessively rich and to emit some smoke. It is normal practice for carburettor heat to be selected to cold during the final approach so that if maximum power is required for a go-around, then the engine is correctly configured. This procedure does not appear to have been carried out during this approach.

The possibility of an undiagnosed technical problem with the engine, perhaps with the fuel system, still remains. The aircraft has since been shipped abroad, and several months after the accident the aircraft was still awaiting repair, and no inspection of the engine had been undertaken. However, there were no obvious defects reported by the new owner.

Whilst the pilot had experience of several tail-wheel types, his lack of experience on this type would appear to be a factor in the heavy subsequent landing. The long nose ahead of the rear cockpit might also have been a contributing factor.

Height AGL	Wind Speed & Direction	Temperature	Dew Point	Humidity
Surface	160/06 kt	15.0	4.4	49%
1,000 ft	190/15 kt	9.3	1.2	57%

Table 1

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-OBIL
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1988
Date & Time (UTC):	18 July 2007 at 1013 hrs
Location:	Peterborough (Conington) Airfield, Cambridgeshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Severe damage to tail rotor and main frame distortion
Commander's Licence:	Student Pilot
Commander's Age:	39 years
Commander's Flying Experience:	68 hours (of which 32 were on type) Last 90 days - 35 hours Last 28 days - 33 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The student pilot was completing his after-start checks in G-OBIL on the concrete apron at Peterborough (Conington) Airfield, Cambridgeshire. As he increased the rotor rpm the aircraft started to rotate anti-clockwise. The aircraft continued to rotate across the ground for approximately six revolutions before the tail rotor hit the grass and the aircraft came to rest. The pilot had left pedal applied as he increased the rotor rpm.

History of the flight

The student pilot had been briefed by his instructor for a visual circuit detail at Peterborough (Conington) Airfield, Cambridgeshire. His instructor planned to join him in the aircraft after he had started the engine. The aircraft was positioned on the dry concrete apron facing south and the wind was 210º/12 kt.

The initial interior and engine start-up checks were completed normally including switching the rotor rpm governor ON when the engine rpm was less than 80%. As the student increased the rotor rpm to 104% the aircraft started to rotate anti-clockwise. He immediately closed the throttle and the rpm initially dropped before quickly rising back to 104%. The aircraft continued to rotate for five or six revolutions across the ground before the tail rotor hit the grass and broke; the aircraft then stopped rotating. Throughout the rotations the collective remained in the fully lowered position. The pilot shut down the aircraft and vacated normally.

Rotor rpm governor

The governor is designed to maintain the rotor rpm between 97 and 104%. It achieves this by mechanically opening and closing the throttle and is only active when the engine is running at more than 80% rpm. If the pilot closes the throttle with the governor active (overriding the governor) and then releases or relaxes his hold on the throttle, the governor will re-open the throttle in a bid to restore the rotor rpm to 104%.

Pilot's comments

The pilot stated that he inadvertently applied left rudder pedal as he opened the throttle, thereby placing an anti-clockwise turning force onto the aircraft. As the aircraft began to rotate he did not consider applying opposite pedal because he was concentrating on keeping the aircraft upright and closing the throttle.

ACCIDENT

Aircraft Type and Registration:	DG505 Elan Orion, BGA 4432 JDN
No & Type of Engines:	None
Year of Manufacture:	1997
Date & Time (UTC):	22 April 2007 at 1542 hrs
Location:	North Hill Airfield, Broadhembury, Honiton, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Gliding Certificate with Silver Badge
Commander's Age:	48 years
Commander's Flying Experience:	144 hrs / 414 launches (of which 5 hrs were on type) Last 90 days - 3 hours Last 28 days - 3 hours
Information Source:	AAIB Field Investigation

Synopsis

The accident occurred during a solo flight, the purpose of which was to convert an experienced glider pilot on to type. On approach, the glider was seen to enter a steep dive and strike the ground, seriously injuring the pilot. The dive was caused by the failure of a piece of electric cable being used to restrain the hinged rear cockpit headrest. This allowed the headrest to fall forward, restricting the rearward travel of the rear cockpit control column resulting in a loss of control. The electrical cable had been fitted as a replacement for the original nylon cord, installed by the manufacturer, which had become damaged. Two Safety Recommendations have been made.

History of the flight

The pilot was in the process of being cleared to fly his club's two-seat DG505 glider, JDN, when the accident occurred. Earlier in the day, he had flown three dual flights with a club instructor before being cleared for a solo flight under the instructor's supervision. The dual flights had been handled well by the pilot and included a practice cable break and short circuit, during which the pilot demonstrated good handling and awareness. Weather conditions were fine, with a light south or south-westerly wind and no significant low cloud. There was no turbulence affecting the circuit or landing area, and the day had been declared suitable for ab-initio solo flying.

After the third dual flight, the instructor vacated the rear seat and the glider was towed back to the launch area whilst the pilot remained in the cockpit. The instructor briefed the pilot and then prepared the glider for solo flight. This included securing the rear seat four-point harness, which the instructor fastened in the normal manner before pulling the straps tight. He also checked that the seat cushion was secure.

The instructor then assumed the role of club duty instructor in the launch control vehicle. The winch launch was uneventful and the glider was seen to carry out a few turns before joining the circuit in a normal manner. The glider's position and height seemed normal in the circuit, and the turn onto final approach appeared co-ordinated and at approximately the correct speed and height.

Several witnesses saw the subsequent events, and their accounts matched closely. The glider quickly adopted a steep nose-down pitch attitude and descended rapidly with little change in attitude until it struck the ground. The front fuselage struck the ground first and the canopy shattered. The glider then pitched up, the tail struck the ground with force and the 'T' tailplane detached. The glider bounced some distance into the air again and began to roll to the right before descending steeply into the ground.

The pilot survived the accident, but sustained serious injuries. An air ambulance and other emergency services arrived on the scene and the pilot was flown to Exeter hospital.

Pilot information

The 48-year-old pilot started gliding with the club in 2002, and had first flown solo in June 2003. Subsequently he had flown regularly at the club and, since April 2006, had flown a Cirrus single-seat glider as part of a syndicate. He was regarded as an experienced and competent club pilot and had been selected for training as a Basic Instructor. The club operated a colour rating system, with a Blue rating being the highest, allowing its holder to fly in the most restrictive or demanding weather conditions. The pilot held the next highest rating, and had completed the majority of the club's requirements for issue of a Blue rating.

The pilot was interviewed in hospital three days after the accident. His recollection of the three dual flights was complete, as it was for the majority of the accident flight. He recalled the turn onto final approach and achieving a satisfactory clearance over trees on the approach path. He also remembered extending the airbrakes, and then partially retracting them to maintain an accurate approach to the normal aiming point. He did not recall any control difficulties but was unable to remember the steep final descent or the initial impact, though he was aware of the second impact and some of the events afterwards.

The pilot held a valid medical declaration and had no known medical condition which could have affected his ability to control the glider.

Wreckage distribution and initial examination

The first ground markings made by the glider were approximately 40 m from the tree line bordering the eastern perimeter of the gliding site. There was no evidence to indicate that the glider had passed through the trees during its descent. Ground markings indicated that the glider initially struck the ground in a nose-down attitude with the wings relatively level. The horizontal stabiliser, including the elevator, had detached from the tail during this impact. It was found approximately 30 m from the initial point of impact, with the elevator jammed in a nose-down position, having been forced beyond its control stops. The glider had become airborne again, travelling for a further 230 m before striking the ground for a second time. These ground markings confirmed that the glider had hit the ground in a steep nose-down attitude with some degree of right roll. A large proportion of both the front and rear canopies were recovered between the first and final impact points.

Examination of the glider at the accident site confirmed that there were no disconnections within the control circuits. However, the rear cockpit headrest was found to have pivoted forward and was resting on the top of the control column (Figure 1), the restraining wire having broken at the point where it was secured to the shoulder harness attachment. A smear of a black plastic-like substance was found on the headrest cover where it had been resting on the control column. The gliding club confirmed that JDN had been kept permanently rigged and club records indicated that it had rarely been flown solo. However, the rear headrest would have been moved forward to install the main battery prior to the first flight of the day and to check the security of the wing rigging pins.

Detailed examination

The glider's instrumentation was examined and showed no evidence of a pre-accident failure. One of the rear mounting pins for the horizontal stabiliser had been distorted which allowed it to be released. The distortion of the pin and damage to the elevator input arm indicated that the force had been produced by the elevator control rod running inside the fin. The mounting points for the control rod within the fin had failed in overload. No evidence was found of pre-impact damage or restriction to the control circuits within the wings, rear fuselage or under the cockpit floor.

The black plastic material on the rear headrest cover originated from the hand grip on the rear control column. Detailed inspection of the hinged seat back in the rear cockpit showed that it had failed approximately half way along its length and the foam at the top of the headrest had been distorted. The failure indicated that a large compressive force had been applied between

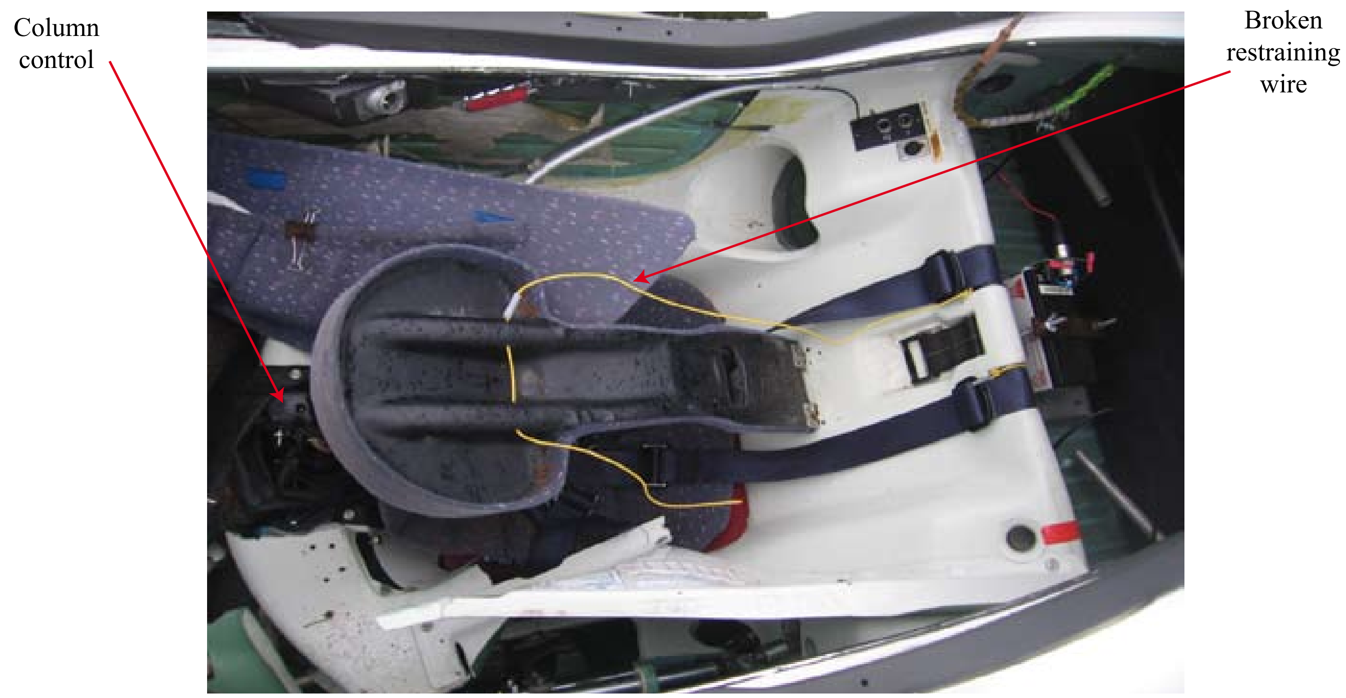

Figure 1

Rear seat headrest in 'as found' condition the top of the headrest and the hinge point. The distortion in the foam matched the shape of a collar at the base of the control column. The length of the headrest was such that, if unrestrained, it would sit on top of the control column when the column was in the neutral position. If the column was then moved forward, the headrest would drop behind it, preventing any rearward movement of the column. In order to prevent the headrest dropping onto the control column, it had been restrained by a length of electrical cable which had failed where it had been secured to the rear shoulder harness location points. The wire was 2.4 mm in diameter, with a conductor made up of 14 x 0.3 mm diameter copper strands.

Manufacturer's Technical Notes

The glider's log book confirmed that it had been delivered 'new' from the manufacturer in 1997. Several modifications were incorporated during the build process, including Technical Note (TN) 348/5 (issued in Feb 1994), regarding the installation of a hinged headrest in the rear cockpit. The hinge was required to allow access to the glider's battery and wing rigging pins. The installation instructions for TN 348/5 stated that the headrest should be restrained by two 3 mm nylon or perlon cords, knotted to prevent the headrest interfering with the control column. The TN made no mention of the minimum strength requirement of the cords. As the release date of TN348/5 pre-dated the date of manufacture of the glider, the gliding club did not hold a copy of the TN nor was one supplied with the glider's delivery documentation.

In March 2001, TN 348/15, titled "*Greasing Schedule/Manual Revision*" was released by the glider's manufacturer, which included the reasons for issue:

> *'The securing ropes of the head rest in the rear cockpit must prevent the head rest from interfering with the rear control stick when the head rest is moved to its most forward position.'*

Item two of the compliance instructions stated:

> *'Check the securing ropes of the head rest in the rear cockpit for wear and correct length. The securing ropes must prevent the head rest from interfering with the rear control stick when the head rest is moved to its most forward position.'*

The manual revisions introduced by TN 348/15 included revisions to both the Maintenance and Flight Manuals, the latter of which introduced a daily inspection of the 'headrest ropes'. The revised sections of the Maintenance Manual made no reference to the 'headrest ropes'. There were two copies of the DG500 series Flight Manual in use at the gliding club; a copy kept permanently in the cockpit of JDN, and a further copy, kept with the maintenance manual, for reference during ground servicing and maintenance. It was noted that the copy kept in the glider had not been amended to reflect the extra daily inspection check.

Annual inspections

From delivery, JDN's annual inspections had been carried out by a single BGA-certified inspector. Shortly after the glider's annual inspection in February 2006, he found the original headrest restraining cord damaged and replaced it with the yellow electrical cable which he believed to be of comparable strength to the nylon cord, although he was aware that the prescribed material for the cord was nylon or perlon.

In early 2007 the same inspector carried out the annual inspection of JDN during which several repairs were carried out, as well as a modification to the rear seat arrangement. The inspector stated that throughout the inspection process he had made use of BGA Form 267 *(Glider Maintenance Schedule Report*), the DG505 Maintenance Manual and the applicable TN's issued by the manufacturer.

When reviewing the Technical Notes, the inspector noted that TN 348/15, titled "*Greasing Schedule/ Manual Revision*", was listed as applicable to JDN. However, as the required greasing had been completed earlier in the inspection, he did not read the content of this TN. He also stated that no reference was made to the Flight Manual (the 'hangar' copy of which contained the reference to the security and condition of the 'headrest ropes') during the inspection process, although he was aware of the requirement to check the headrest cord during each daily inspection. The amendment state of the Flight Manual(s) was a required check under item 62 *("Flight Manual Revision")* of the BGA Form 267 but this was not carried out in respect of the copy kept in the glider, which did not contain the revised instructions regarding the 'headrest ropes'.

Other members of the gliding club (including some responsible for completing the glider's daily inspections) were not familiar with the requirements to inspect the headrest cord. Although they were aware that the electric cable was not an approved item and its continued use had been raised in discussions, they commented that they had accepted the yellow cable as a suitable means of retention.

Tests of the rear-seat headrest

Examination of a DG505 owned by another Gliding Club showed that the headrest would fall forward at 9.5 degrees of aircraft nose-down pitch. In the event of the glider decelerating, such as during airbrake deployment, the headrest could fall forward at a lower nose-down angle. Attempts to provide an additional method of securing the headrest using the rear-seat harness proved unsuccessful. Club members confirmed that after solo flights the seat back was always found in the forward position, restrained by the cable. It was discovered that with the headrest 'unrestrained' and in its lowest position, the control column, if displaced forward, was prevented from returning to the neutral position and the elevator could not be moved up past 4^{o} nose down.

Tests were carried out using electrical cable with the same number and diameter of conductor strands as the cable fitted to JDN's headrest. In the first test a tensile load was applied to a length of test cable and this showed that it was capable of holding a tensile load of 343.4 N. This was equivalent to suspending a 30 kg mass from the cable before the cable deformed. The mass of the headrest when measured was 1.1 kg. As the original nylon retaining cord had not been retained, it could not be tested and as no material specification for the nylon cords were given in TN 348/5, no estimation of the tensile load capabilities of a similar cord could be made.

In the second test, the headrest was allowed to fall forward until restrained by a cable attached to a load cell. The maximum recorded load was 43 N. In the final test, the headrest was restrained by a matching length of test cable, and repeatedly allowed to fall forward until the cable failed. This test was repeated five times. During the final test, the test cable failed in the same place as the cable fitted to JDN, at between 32 and 36 'falls' of the headrest. The physical properties of copper are such that under repetitive bending it becomes locally 'work hardened' and prone to fracture. The position of the break in the wire fitted to JDN, where it was tied to the shoulder harness attachment, corresponded to a point where the wire would be subject to repetitive bending and straightening when the headrest was moved.

Safety actions

The BGA contacted all owners of DG500 series gliders to highlight the hazard a poorly restrained rear cockpit headrest could present. They also reminded owners of the correct method of restraint and the inspection requirements contained within the Flight Manual.

As a result of this accident, the gliding club concerned carried out a review of its procedures for approving members to carry out daily inspections, to ensure that they are fully conversant with the manufacturers' requirements for each glider type.

Analysis

It is clear from the eye-witness reports and evidence from the accident site that the glider flew an abnormally steep final descent, with little or no change in its attitude until it struck the ground. Considering that the pilot was an experienced and respected club member and that he had demonstrated his ability to control the glider safely under both normal and emergency conditions, it is extremely unlikely that the accident was a result of mishandling or poor judgement.

The pilot held a valid medical declaration and was in good health on the day of the accident. Although he could not recall the final dive and initial impact, this is not unusual in traumatic events such as accidents. Consequently it was considered that sudden pilot incapacitation was not a factor in this accident.

The engineering investigation established that there were no disconnections within the control circuits, and that the glider's instrumentation was functioning normally immediately before the accident. The damage to the horizontal stabiliser locating pins, elevator control arm and the elevator control rod in the fin indicated that the initial impact drove the control rod up with sufficient force to distort the rear mounting pins, which then allowed the stabiliser to be released. The loss of the stabiliser and elevator during this impact would have made the glider uncontrollable in pitch when it became airborne for the second time.

The damage to the top of the rear headrest and the compressive fracture of the headrest structure, indicated that the headrest had dropped behind the rear control column and that the column had been pushed against the headrest with considerable force. The black deposit on the headrest confirmed that it had also come into contact with the top of the rear control column with some force. It is unlikely that sufficient force would have been exerted by the pilot before impact to fracture the headrest itself, so it was probably already in its lowered position when the accident occurred and would have restricted rearward movement of the control column. Examination confirmed that the headrest would readily fall forward when the type is flown solo and if unrestrained could fall behind the control column causing a restriction.

The use of two nylon restraining cords, as detailed in TN 348/5, would have provided some degree of redundancy, although the inspector who carried out JDN's annual inspections believed that it was delivered with just a single restraining cord. This would account for the fact that, when it was replaced, only a single loop of wire was used, replicating the existing arrangement.

The lack of a specification in TN 348/5 for the nylon cords and the reliance on 'knotting' to form the loops meant that it was not possible to make a comparison between the tensile strengths of the nylon cords and the electrical cable used on JDN. The tensile strength of the electrical cable used in the tests indicated that it appeared to be more than capable of restraining the headrest. However, the physical properties of copper make the use of a 'copper cored' cable unsuitable in an application were it would be subject to repeated bending. The repetitive 'drop' tests confirmed that the installed wire would fail after relatively few 'drops' of the headrest.

Regardless of the restraint system, the hinged headrest, introduced by Glaser Dirks Technical Note 348/5, represents a potential restriction to the movement of the rear cockpit control column when the glider is flown solo. The following Safety Recommendation is therefore made:

Safety Recommendation 2007-127

It is recommended that the Luftfahrt-Bundesamt and the EASA require DG-Flugzeubau GmbH to review the design of the hinged headrest introduced to the DG500 series glider by Glaser Dirks Flugzeubau GmbH Technical Note 348/5 to remove any possibility of a control restriction in the event that the headrest becomes unrestrained.

The inspector who carried out the glider's 2007 annual inspection did so without reference to the content of TN 348/15, believing it to be related to greasing requirements, a task he had already carried out. However, TN 348/15 did contain significant safety information regarding the headrest securing ropes but this was contained only in the body of the text and not reflected in the title.

The use of a single Technical Note to publish instructions regarding multiple subjects, including those with implications to operational safety, leads to the possibility that the significance of information related to the safety of the glider may be overlooked. The following Safety Recommendation is therefore made:

Safety Recommendation 2007-128

It is recommended that DG-Flugzeubau GmbH review their document publication procedures to ensure that safety related information is published in an independent document.

Although TN 348/15 referred only to the security of the headrest ropes and not to their material or method of attachment to the glider's structure, the inspector was aware that the wire he had previously substituted for the original restraining cord did not meet the manufacturer's specification. Although he believed that the existing arrangement was fulfilling the requirements of TN 348/15, and therefore certified the glider for continued service, he did so with the knowledge that a non-approved part had been fitted for at least 12 months.

The Flight Manual kept in JDN was the primary reference for pilots flying the glider and conducting daily inspections. Because of its incorrect amendment state, club members were not aware of the changes to the daily inspection in respect of the 'headrest ropes'.

Manufacturer's follow-up actions

The manufacturer considered that the information introduced in to the AFM by TN348/15, concerning the check of the headrest ropes, was clear and unambiguous. It also observed that owners or operators of their aircraft had a responsibility to address all items raised in each TN. The manufacturer stated that the correct installation of the headrest ropes is regarded as fail-safe as only one is actually needed to secure the headrest. Advice or guidance regarding the correct method of headrest restraint would have been readily available from the manufacturer had it been sought by the BGA inspector concerned. As a precaution against similar oversights in the future, the manufacturer re-published TN348/15 in its last pilot information publication.

Conclusion

The accident was caused by the failure of a piece of electrical cable used to restrain the hinged rear cockpit headrest. This fell forward at some stage of the flight and, as the pilot manipulated the controls during the approach to landing, became lodged behind the rear control column, denying the pilot the pitch control necessary to recover from the ensuing dive. The electrical cable that had been fitted was a replacement for the original nylon cord, installed by the manufacturer, which had become damaged. The cable did not meet the manufacturer's specifications and the mechanical properties of copper wire made it unsuitable for this purpose.

ACCIDENT

Aircraft Type and Registration:	Dragon 200, G-MMAE
No & Type of Engines:	1 Fuji-Robin EC-44-PM piston engine
Year of Manufacture:	1983
Date & Time (UTC):	11 August 2007 at 1010 hrs
Location:	Sandown Airport, Isle of Wight
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Undercarriage collapsed, propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	876 hours (of which 50 were on type) Last 90 days - 13 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB inquiries

Synopsis

The aircraft took off from a grass strip, towards rising ground at close to its maximum all up weight. It encountered turbulence and then made a forced landing after the end of the runway and was extensively damaged. Whilst the aircraft's performance figures show that it should have been able to complete this manoeuvre, the aircraft did not perform as expected. One Safety Recommendation has been made.

History of the flight

The owner of the aircraft flew from Lee-on-Solent to Sandown Airport to show the aircraft to some prospective buyers. The owner and one of the potential purchasers decided to take the aircraft for a short flight. With the pilot, his passenger and the fuel on board, the aircraft's takeoff weight was 373 kg; the aircraft's maximum takeoff weight was 384 kg.

Runway 23 was the runway in use at Sandown. It is a grass strip 884 m long. The threshold at Runway 23 is 23 ft amsl, and the threshold of Runway 05 is 55 ft amsl; there is thus an upslope of approximately 1.1 % on Runway 23. Outside the airfield boundary, in the takeoff direction of Runway 23, the ground continues to rise. There are some houses at the top of the rise.

The weather conditions were good, with a light and variable wind, a temperature of 22ºC and a QNH of

1018 mb. The aircraft taxied for a departure from Runway 23, utilising the full length of the runway, and the ground run and initial climb were reported as normal. The pilot reported that the aircraft was climbing at 30 mph when, at a height of approximately 50 ft, the aircraft encountered turbulence and the right wing dropped. He corrected the wing drop, but in the turbulent conditions the wing dropped again. After recovering the wing for the second time he realised that the aircraft was descending. The pilot confirmed that his airspeed was still 30 mph, and that the engine was still at full power (6,500 rpm). He assessed that he was unable to clear the obstacles beyond the runway so he decided to land and closed the throttle. He was unable to reduce the subsequent high rate of descent, because of reduced elevator authority at the low speed, and the aircraft struck the ground in a level attitude. The undercarriage collapsed, the propeller struck the ground and the engine stopped. The pilot then switched off the fuel and electrics, and he and his passenger, who were both uninjured, vacated the aircraft normally.

The pilot considered that the most likely cause of the accident was due to the effects of thermal activity. He believed that he had probably flown into a downdraft, which had exceeded 250 ft/min; the aircraft's maximum rate of climb at its takeoff wight. As the airspeed remained around 30 mph he did not consider that the aircraft was stalled.

Aircraft information

The Microlight type acceptance data sheet No BMO-34 Issue 2, contains information about the Dragon 150 and 200 aircraft. The data sheet includes limitations, performance information, and inspection and flight testing notes. It states the following:

'• *During flight testing the stall speed at the maximum authorised weight is to be checked for each aeroplane and recorded (as IAS).*
• *The maximum take off weight for this aircraft is 384 kg.*
• *Minimum performance is a rate of climb of 300 ft per min. (No weight is stated)*
• *Climb speed is 30 kts*
• *Stall speed is 21 kts (idle power)*
• *Maximum rpm of the Fuji-Robin EC-44-PM piston engine is 7,000'*

Aircraft performance

On 10 April 2007, G-MMAE completed its permit to fly renewal flight. For this flight the aircraft had a takeoff weight of 292 kg. It achieved a maximum engine rpm on the ground of 6,700 and it achieved a rate of climb of 333 fpm. It stalled at 25 mph (21.7 kt).

The designer of this aircraft was asked to extrapolate the results from the test flight to provide an estimate of the aircrafts performance for a takeoff weight of 373 kg, which was the takeoff weight at Sandown on 11 August 2007. His calculations produced the graph at Figure 1.

It can be seen that at a takeoff weight of 373 kg the aircraft designer estimated that the aircraft would have been able to achieve a rate of climb of less than 30 fpm, which is equivalent to a gradient, in still air, of approximately 1%.

The Fuji Robin EC-44-PM engine produced 50 bhp (brake horse power) when certified in the Dragon 200. The designer calculated that a rate of climb of 333 fpm at 292 kg equates to the engine producing only 39.5 bhp.

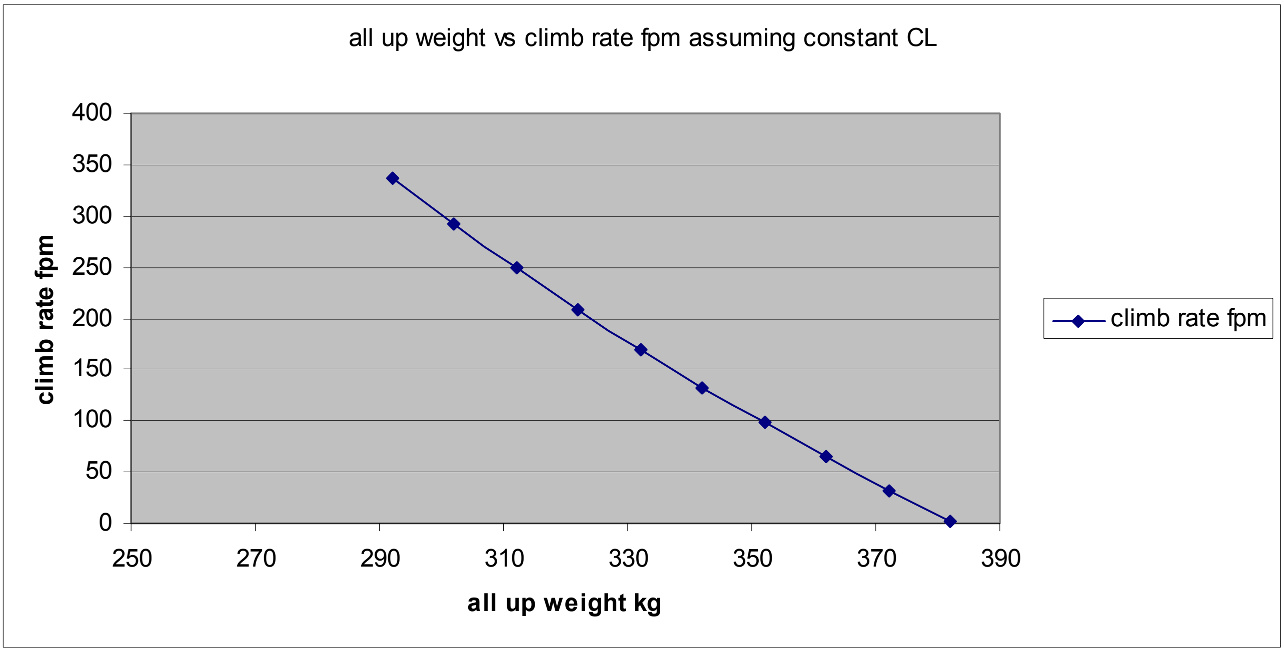

Figure 1

The aircraft has a recommended climb speed of 30 kt. This aircraft was fitted with an ASI that was calibrated in mph. The aircraft should therefore have been flown at 35 mph in the climb. The designer also calculated that the aircraft would stall at 28 mph (24.3 kt) at a weight of 373 kg.

Comment

The climb performance of the aircraft, at the takeoff weight of 373 kg, was calculated to be approximately 1%, and the aircraft was flying towards rising ground. The pilot was attempting to maintain 30 mph instead of the recommended climb speed of 30 kt; this would have reduced the margin from the stall speed as well as degrading the climb performance. Shortly after takeoff the aircraft encountered some form of turbulence; given the normal tolerances for an airspeed indicator, it seems possible that the aircraft became partially stalled.

Safety Recommendation

This aircraft had completed its BMAA check flight schedule for a permit to fly revalidation four months before the accident. A closer analysis of the figures show that the aircraft was not performing as it was required to, and yet this was not detected. It seems likely that the inadequate performance was as result of the engine not delivering full power. Had the aircraft's performance at its maximum takeoff weight been recognised, then it would not have had its permit to fly revalidated and this accident would have been avoided. This did not require the aircraft to be tested at its maximum takeoff weight. The data could have been extrapolated to ensure that the calculated climb rate was not seriously below that scheduled in the type acceptance data sheet.

Safety Recommendation 2008-001

It is therefore recommended that the CAA, in conjunction with the BMAA and PFA, ensure that during the check flight for a permit to fly revalidation, the aircraft's performance, at its maximum certified takeoff weight, is confirmed.

ACCIDENT

Aircraft Type and Registration:	EV-97 Team Eurostar, G-CESF
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2007
Date & Time (UTC):	6 September 2007 at 1625 hrs
Location:	Saddington, Leicestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to landing gear, both wings and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	327 hours (of which 11 were on type) Last 90 days - 18 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Shortly after landing at a private airstrip at Saddington, Leicestershire, the pilot realised that the aircraft was not slowing down, despite the application of brakes. He decided to steer the aircraft into a field to the right of the grass runway, but the aircraft did not stop and it entered a ditch. Ground marks indicated that the brakes were applied. Later examination of the aircraft found the throttle to be partially open.

History of the flight

Following a flight of about 1.5 hours, the pilot decided to carry out a 'touch-and-go' at a private airstrip near Saddington, Leicestershire. The strip was of short grass orientated 220º/040º and 300 metres long. The grass was dry and the runway surface was firm. The weather on the day was calm, with good visibility. The pilot had previously landed at the airstrip on several occasions in a Thruster although, this was his first visit in a Eurostar. He had previously completed 'short' and 'soft field' landings in the Eurostar, at another airstrip.

Having carried out a successful touch-and-go on Runway 04, the pilot then decided to carry out a landing at the strip. The approach to Runway 04 was stable, but, the aircraft landed short of the intended touchdown point. As there appeared to be ample runway left in which to stop, the pilot did not apply the brakes immediately. When the brakes were applied, the aircraft did not to slow down. As the pilot was unsure of what the problem was, he decided to remain on the ground and did not attempt to take off again. The pilot then steered the aircraft to the right, toward an open field of short grass, in an attempt to increase the retardation. However, the aircraft did not stop and entered a ditch at a ground speed of between 20 and 25 kt finally coming to rest in the ditch. The pilot and passenger were uninjured and were able to exit normally. There was no fire.

The pilot reported that ground markings on the runway and the field indicated that the brakes had been applied.

Later examination of the aircraft revealed that the throttle was partially open. A check of the throttle and its friction lever showed them to be operational. It is possible that prior to, or during, the landing roll the throttle friction may have loosened, allowing the throttle to open and apply enough engine power to overcome the braking action of the aircraft.

ACCIDENT

Aircraft Type and Registration:	Kiss 400-582(1) microlight, G-CBJA
No & Type of Engines:	1 Rotax 582/48-2V piston engine
Year of Manufacture:	2002
Date & Time (UTC):	22 July 2007 at 1720 hrs
Location:	Over Farm Airfield, Gloucestershire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Aircraft extensively damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	100 hours (of which 17 were on type) Last 90 days - 13 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the approach, the aircraft contacted a large bush, somersaulted, and crash-landed on its wheels. The pilot was uninjured.

History of the flight

Whilst on final approach, the pilot allowed the aircraft to descend too low and attempted to compensate by stretching the glide. The aircraft continued to descend and, perceiving that it might collide with a large bush on the approach path, he applied full engine power. This action proved too late and the trike contacted the top of the bush, causing the aircraft to perform a forward somersault, before landing on its wheels, right way up. Although the aircraft was extensively damaged, the pilot, who was wearing a lapstrap, was uninjured.

ACCIDENT

Aircraft Type and Registration:	Mainair Mercury, G-MYCV
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1992
Date & Time (UTC):	5 April 2007 at 1230 hrs
Location:	Arclid, near Sandbach, Cheshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Aircraft severely damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	97 hours (of which 65 were on type) Last 90 days - 12 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

As the aircraft lifted off during the takeoff, it veered sharply to the right and collided with a substantial hedge.

History of the flight

The pilot and his passenger arrived at the airfield and rigged the aircraft in preparation for a local flight. After completing the pre-flight checks, the pilot taxied the aircraft to Runway 02 and noted that the wind was approximately 5 kt from the northwest. This gave a small crosswind component from the left. Full power was applied for the takeoff run but, as the aircraft lifted off, it veered sharply to the right and collided with a substantial hedge at the side of the runway. Two other pilots, who were close by, provided assistance to the aircraft occupants and summoned an ambulance. Both were taken to hospital, where the pilot was found to have sustained a broken ankle and rib; the passenger was uninjured.

In a frank statement, the pilot noted that he had not taken account of the increased weight of the aircraft as a result of having a passenger on board and had lifted the aircraft off in a stalled condition.

ACCIDENT

Aircraft Type and Registration:	Pegasus Xl-R, G-MTIP
No & Type of Engines:	1 Rotax 447 piston engine
Year of Manufacture:	1987
Date & Time (UTC):	2 August 2007 at 1000 hrs
Location:	Near Berhills Lane, Seend, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Extensive damage to the wing, trike and rigging wires
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	109 hours (of which 72 were on type) Last 90 days - 12 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional AAIB enquiries

Synopsis

Following an engine failure, the pilot attempted a forced landing into a field. During the ground roll, on a downhill gradient with damp grass, the nosewheel entered a ditch at the edge of the field, causing the aircraft to flip over and come to rest inverted on the boundary fence.

History of the flight

The aircraft was on a local flight from a farm strip when it encountered light rain. The pilot decided to return to the airfield and, in order to save time, planned to join the circuit on base leg. However, whilst maintaining 500 ft agl and a typical cruise power setting of 5,000 rpm, the engine cut out without warning. A number of fields appeared to be suitable for a forced landing and the pilot chose what he thought was the best one. The landing was slightly deep, as a result of having to avoid trees on short finals. Having touched down, it became apparent that the field had a downhill gradient which had not been obvious from the air. The slope, combined with the damp conditions, made it impossible for the pilot to stop the aircraft before reaching a ditch and fence on the field boundary. The nosewheel fell into the ditch, causing the aircraft to flip over and come to rest on the fence in an inverted attitude. Neither occupant was injured, although the aircraft sustained major damage.

A subsequent investigation did not reveal the reason for the engine failure; it had not seized and the ignition system was found to be serviceable. Should any further information relating to this accident come to light, it will be published in a future AAIB Bulletin.

ACCIDENT

Aircraft Type and Registration:	Tanarg/Ixess 15 912S(1), G-CEBH
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2006
Date & Time (UTC):	25 April 2007 at 1315 hrs
Location:	Roddige Airfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Fuselage pod and front steering mechanism damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	398 hours (of which 13 were on type) Last 90 days - 11 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

History of the flight

The aircraft was flying from Roddige Airfield, Staffordshire on a local flight. The weather conditions were described as good. On returning to the airfield the pilot positioned the aircraft to land on Runway 09. This runway was 440 m in length and its grass surface was dry. The pilot reported that the speed was a little fast on short finals, and when he flared to land the aircraft it 'ballooned'. The aircraft landed heavily, went off the side of the runway into a crop of rape and rolled over onto its side. The pilot was uninjured. The fuselage pod and the front steering mechanism were damaged.

AIRCRAFT ACCIDENT REPORT No 1/2008

This report was published on 10 January 2008 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE SERIOUS INCIDENT TO BOMBARDIER CL600-2B16 CHALLENGER 604, VP-BJM 8 NM WEST OF MIDHURST VOR, WEST SUSSEX ON 11 NOVEMBER 2005

Registered Owner and Operator:	Southern Air - Nigeria
Aircraft Type and Model:	Bombardier CL600-2B16 Challenger 604
Nationality:	Bermuda register
Registration:	VP-BJM
Location:	8 nm west of Midhurst VOR, West Sussex
Date and Time:	11 November 2005 at 1522 hrs

Synopsis

This serious incident was notified to the Air Accidents Investigation Branch (AAIB) by the London Terminal Control Centre (LTCC) on 11 November 2005, the day of the occurrence, and the investigation began that day. The following Inspectors participated in the investigation:

Mr R D G Carter	Investigator-in-charge
Mr P Sleight	Engineering
Mr J Firth	Operations
Mr J R James	Flight Recorders

About four and half hours into a flight from Lagos, Nigeria, the autopilot pitch trim failed and subsequently the stabiliser trim system failed. Attempts were made to re-engage the stabiliser trim channels, resulting in channel 2 appearing to engage with no response to trim commands, and channel 1 engaging intermittently. During the flight the stabiliser occasionally trimmed nose down, despite applications of nose-up trim commands. The trim eventually reached almost full nose down. To counteract this, both flight crew members had to apply prolonged aft pressure on the control column. The aircraft diverted to London Heathrow for a landing with flap retracted, although the QRH required 20° flap following a stabiliser trim failure. The commander made the decision as the crew considered that applying flap would substantially increase the control column load required to maintain level flight.

Subsequent investigation found contamination, formed by electro-migration in the presence of moisture, within the Horizontal Stabiliser Trim Control Unit (HSTCU). The moisture was probably created by humid air condensing on the cooling motherboard during prolonged flight at altitude.

The investigation identified the following causal factors:

1. In the absence of a mechanical backup system or sufficient physical separation of the control channels, there was insufficient protection within the design of the HSTCU against the effects of environmental contamination.

2. The airworthiness requirements relating to the design and installation of electronic components did not sufficiently address the specific effects of fluid and moisture contamination as a source of common cause failures.

One Safety Recommendation is made in this report and one was made earlier in the investigation.

Findings

1. The flight crew members were properly licensed to conduct the flight.

2. The flight was uneventful until the autopilot pitch trim failed about four and a half hours into the flight, followed by the stabiliser trim system.

3. Attempts by the crew to re-engage the stabiliser trim channels were not successful.

4. The stabiliser occasionally trimmed 'aircraft nose down', despite applications of nose-up trim commands, and reached almost full nose down.

5. To counteract the runaway trim, both flight crew members had to apply prolonged aft pressure on the control column.

6. The aircraft diverted to London Heathrow for a landing with flap retracted, although the QRH required 20° flap following a stabiliser trim failure.

7. The commander made the decision to land with flap retracted, as he was concerned that applying flap would substantially increase control loads required for level flight.

8. The runaway trim condition was caused by electrical shorting, in the presence of moisture, within the Horizontal Stabiliser Trim Control Unit (HSTCU).

9. The moisture was probably created by humid air condensing within the HSTCU during the prolonged flight at altitude.

10. The electrical shorting within the HSTCU affected both pitch trim control channels due to their physical and functional proximity in the unit.

11. With no separate mechanical backup system, there was insufficient system separation, and thus independence, between the control channels in the HSTCU.

12. The design of the HSTCU had insufficient environmental protection against moisture ingress.

13. There had been a number of previous occurrences of contamination within HSTCUs, of which the aircraft and component manufacturers were aware.

Safety Recommendations

The following Safety Recommendation was made shortly after the incident, in AAIB Special Bulletin S3/2005:

Safety Recommendation 2005-147

It is recommended that Transport Canada ensure that Bombardier Aerospace eliminate the risk of contamination affecting the operation of the horizontal stabiliser trim control system fitted in the Challenger 604 and other Bombardier aircraft with similar trim systems.

The Safety Recommendation was transmitted to Transport Canada through the Transportation Safety Board in Canada. The response is noted in the report under Section 5, Safety Actions Taken.

Safety Recommendation 2007-061

It is recommended that the EASA, in collaboration with other airworthiness authorities, including the FAA and Transport Canada, amend their requirements relating to the design and installation of electronic components in aircraft, so that fluid and moisture contamination, as a source of common cause failures, is specifically taken into account and adequate measures take place to minimise the risk.

AIRCRAFT ACCIDENT REPORT No 2/2008

This report was published on 17 January 2008 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE SERIOUS INCIDENT TO AIRBUS A319-131, G-EUOB DURING THE CLIMB AFTER DEPARTURE FROM LONDON HEATHROW AIRPORT ON 22 OCTOBER 2005

Registered Owner and Operator:	British Airways PLC
Aircraft Type and Model:	Airbus A319-131
Registration:	G-EUOB
Manufacturer's Serial Number:	1529
Place of Incident:	During the climb after departure from London Heathrow
Date and Time:	22 October 2005 at 1926 hrs

Synopsis

The incident occurred at 1926 hrs on 22 October 2005, to an Airbus A319-131 aircraft which was operating a scheduled passenger flight between London Heathrow and Budapest. The following Inspectors participated in the investigation:

Mr A P Simmons	Investigator-in-Charge
Ms G M Dean	Operations
Mr R G Ross	Engineering
Mr P Wivell	Flight Recorders

As the aircraft climbed to Flight Level (FL) 200 in night Visual Meteorological Conditions (VMC) with autopilot and autothrust engaged, there was a major electrical failure. This resulted in the loss or degradation of a number of important aircraft systems. The crew reported that both the commander's and co-pilot's Primary Flight Displays (PFD) and Navigation Displays (ND) went blank, as did the upper ECAM[1] display. The autopilot and autothrust systems disconnected, the VHF radio and intercom were inoperative and most of the cockpit lighting went off. There were several other more minor concurrent failures.

The commander maintained control of the aircraft, flying by reference to the visible night horizon and the standby instruments, which were difficult to see in the poor light. The co-pilot carried out the abnormal checklist actions which appeared on the lower ECAM display; the only available electronic flight display. Most of the affected systems were restored after approximately 90 seconds, when the co-pilot selected

Footnote

[1] Electronic Centralised Aircraft Monitoring system - this comprises two centrally mounted electronic display units, which present the flight crew with aircraft systems information, warning and memo messages and actions to be taken in response to systems failures.

the AC Essential Feed switch to Alternate ('ALTN'). There were no injuries to any of the 76 passengers or 6 crew. After the event, and following discussions between the crew and the operator's Maintenance Control, the aircraft continued to Budapest.

The Air Accidents Investigation Branch (AAIB) became aware of this incident on 28 October 2005, through the UK Civil Aviation Authority's Mandatory Occurrence Reporting (MOR) scheme. The AAIB investigation team was assisted by an Accredited Representative from the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA, the French air accident investigation authority) and by the aircraft manufacturer.

Preliminary information on the progress of the investigation was published in AAIB Special Bulletins S2/2005 and S3/2006, in November 2005 and April 2006. Four Safety Recommendations were made in Special Bulletin S3/2006.

It was not possible to determine the cause of the incident due to a lack of available evidence, however, nine additional Safety Recommendations are made in this report.

Findings

Personnel

1. The flight crew were licensed and qualified to operate the flight.
2. The flight crew were in compliance with the applicable flight time and duty time limitations.
3. The flight crew had not received any formal training on how to operate A320-family aircraft by sole reference to the standby instruments.
4. The commander did not record the full details of the incident in the aircraft technical log, however he did record this information on the Air Safety Report which he filed.
5. The engineer in Budapest (who was not an employee of the airline), did not investigate the symptoms of the incident which were reported to him verbally by the commander and which were also recorded in the Air Safety Report.

The aircraft

1. The aircraft held a valid Certificate of Airworthiness and no relevant recorded defects were being carried.
2. The aircraft was maintained in accordance with an EASA-approved maintenance programme.
3. The aircraft suffered the loss of the left electrical network, for reasons which could not be established. A possible explanation is the detection of a false DP2 condition by the No 1 Generator Control Unit, but this could not be confirmed.
4. The loss of the left electrical network caused various systems powered by the left network to either cease operating, or become degraded. These systems included, most notably, the autopilot, the autothrust system, the captain's and co-pilot's Primary Flight and Navigation Displays, the upper ECAM display, most of the cockpit lighting, including the integral lighting to the instruments and standby instruments, the VHF 1 and VHF 2 radios and the ATC 1 transponder.

5. The majority of the aircraft systems were recovered after approximately 90 seconds, after selection of the AC ESS FEED switch, in accordance with the ECAM procedure. AC BUS 1 was recovered after approximately 135 seconds, by cycling of the No 1 generator switch.

6. This and other similar incidents show that there is at least one unforeseen failure mode on A320 family aircraft, which can cause the simultaneous loss of the captain and co-pilots electronic flight instruments and the upper ECAM display.

7. Aircraft equipped with an electromechanical standby horizon and not provisioned with the ISIS wiring configuration have a single power supply to the standby horizon, from the DC ESS bus. If this incident had occurred to such an aircraft, the standby horizon would have been unpowered and become unusable after approximately five minutes.

8. The A318/A319/A320/A321 MMEL allows the aircraft to be dispatched with the lower ECAM display inoperative. In this case, it was the only display available and presented the list of actions, which enabled the crew to recover most of the failed systems.

9. Trials showed that in night conditions, there may be insufficient light available to see the standby instruments following the loss of the left electrical network, particularly if the cockpit dome light is off.

Organisational

1. The information contained in the ASR raised by the commander should also have been reflected in the aircraft technical log. The technical log did not contain important details of the incident; as a result it reflected only minor defects which were rectified without appreciation of the importance of the serious incident which had occurred.

2. The faxed copies of the Air Safety Report raised by the commander were not received by the airline's Flight Operations Safety Department, or the department responsible for entering the incident data on to the electronic safety management database. As a result of this and of the minimal information contained in the Technical Log, the significance of the incident was not fully understood until the original copy of the ASR arrived in the post at London Heathrow.

Recorded flight data

1. Airbus has found a failure mode by which the co-pilot's ND and PFD could have been switched from the functional DMC2 to the failed DMC3 whilst leaving the lower ECAM linked to DMC2, however, no link has been found between this failure mode and the failure of power on the aircraft.

2. Because the mechanism by which the power failure on the captain's side resulted in the additional loss of the co-pilot's instruments is not known, it cannot have been considered when analysing failure modes for compliance with requirements.

3. The system BITE designs have been improved to better capture this type of failure. BITE is not recorded by the FDR. Detailed evidence may be lost in the event of an accident caused by the failures involved in this incident.

4. The display behaviour was not apparent from the recorded data. Only the crew observations revealed the extent of the problem. This evidence may be lost in the event of an accident.

5. A crash protected image recording of the instruments would have provided more detail to this investigation and provided crucial evidence that may otherwise have been missing had crew observations not been available.

Causal factors

The investigation identified the following causal factors:

1. The aircraft suffered the loss of the left electrical network, resulting in loss of the captain's PFD and ND, and the upper ECAM display, for reasons which could not be determined.

2. A co-incident failure caused the co-pilot's Primary Flight Display and Navigation Display to blank or become severely degraded, at the same time as the loss of the left electrical network. The origin of the co-incident failure could not be identified.

Safety Recommendations

The following Safety Recommendations were made during this investigation and were published in April 2006 in AAIB Special Bulletin 3/2006:

Safety Recommendation 2006-051

It is recommended that the aircraft manufacturer, Airbus, reviews the existing ECAM actions for the A320-series aircraft, given the possibility of the simultaneous in-flight loss of the commander's and co-pilot's primary flight and navigation displays. They should consider whether the priority of the items displayed on the ECAM should be altered, to enable the displays to be recovered as quickly as possible and subsequently issue operators with a revised procedure if necessary.

Airbus has responded to this Safety Recommendation stating that it would not be acceptable to change the priority of the ECAM action items for the following reasons:

- there are other failure modes in which the selection of the AC ESS FEED is not the most important action,

- the current ECAM action prioritisation was arrived at after taking into account many different safety analyses,

- Changing the priority of the ECAM items would require validation on all airframe engine combinations and could have an impact on other engine or electrical alerts,

- New priorities could introduce new operational issues which would need to be reviewed and approved by the regulatory authorities (EASA/FAA).

Safety Recommendation 2006-052

It is recommended that the aircraft manufacturer, Airbus, should review the A320-series aircraft Master Minimum Equipment List Chapter 31, INDICATING/RECORDING SYSTEMS and reconsider whether it is acceptable to allow the ECAM lower display unit to be unserviceable. They should amend the requirement, as necessary, to take account of the possibility of the simultaneous in-flight loss of both the commander's and co-pilot's primary flight and navigation displays and the ECAM upper display.

In response to this Safety Recommendation, Airbus has reviewed the content of the A318/A319/A320/A321 MMEL regarding dispatch with the lower ECAM display inoperative.

MMEL Sections 1 and 2 were updated in August 2006 to include the condition that an operational test of the AC Essential bus transfer function and indication must be performed once per day if the lower ECAM is inoperative. The Aircraft Maintenance Manual will also be updated to include the test procedure.

This Safety Recommendation was made to ensure that the operating crew would always have information presented on ECAM as to the actions required to recover the systems should a similar event occur. The response of Airbus to the recommendation did not address this problem, which is that if the Lower ECAM screen were not available, in the event of a similar failure, there would not be any information displayed to the crew as to what action they should take to recover the systems. Accordingly, Airbus propose to amend the A320 family MMEL section 2 regarding dispatch with the lower ECAM inoperative, to remind crews of the necessary recovery action should the AC ESS bus, and therefore all DUs be lost:

> 'In case of failure of AC Bus 1, all DUs are lost:
>
> - Apply AC ESS BUS FAULT procedure of FCOM 3.02.24 (Select AC ESS FEED at ALTN) to recover AC ESS BUS'

Safety Recommendation 2006-053

The aircraft manufacturer, Airbus, should identify those aircraft with the single power supply to the standby artificial horizon and advise the operators of the potential implications of this configuration.

In response to this Safety Recommendation Airbus has advised operators through OIT 9SE999.0115/05/BB Rev 1, that for aircraft without the ISIS wiring configuration to the standby instruments, the standby horizon may be unusable after five minutes if the DC ESS bus is lost.

Safety Recommendation 2006-054

It is recommended that the aircraft manufacturer, Airbus, revises the information about the power sources for the standby artificial horizon provided in Flight Crew Operating Manuals for the A320-series aircraft to reflect the actual status of the aircraft to which they apply.

In response to this Safety Recommendation Airbus has updated A320 family Flight Crew Operating Manual Section 3.02.24 page 11, Section 1.34.20 page 1 and Section 1.34.97 page 1 to reflect the different power supply configurations for the standby horizon.

The following additional Safety Recommendations are also made:

Safety Recommendation 2007-062

It is recommended that the European Aviation Safety Authority should, in consultation with other National Airworthiness Authorities outside Europe, consider requiring training for flight by sole reference to standby instruments for pilots during initial and recurrent training courses.

Safety Recommendation 2007-063

Airbus should introduce a modification for A320 family of aircraft which have the pre-ISIS wiring configuration for the standby instruments, in order to provide a back-up power supply which is independent of the aircraft's normal electrical power generation systems.

Since the issue of Special Bulletin 3/2006, Airbus has advised that Modification 37317 has been introduced by Service Bulletin SB A320-24-1120 issued May 2007. This modification provides an automatic reconfiguration of the power supply to the AC ESS bus in the event of AC 1 bus failure. This modification largely satisfies the intent of Safety Recommendation 2007-063.

Safety Recommendation 2007-064

The European Aviation Safety Agency should mandate either Airbus Service Bulletin SB A320-24-1120 or the provision of a back-up power supply for the standby horizon which is independent of the aircraft's normal electrical power generation systems, on A320 family aircraft.

Safety Recommendation 2007-065

In order to ensure that the standby instruments on A320 family aircraft remain adequately illuminated following the loss of the left electrical network, Airbus should introduce a modification to provide a power supply for the standby instrument integral lighting which is independent of the aircraft's normal electrical power generating systems.

In response to Safety Recommendation 2007-065 while it was still at the draft stage, Airbus advised that Service Bulletin A320-33-1057 had been issued in May 2007 to introduce Modifications 37329 and 37330. These modifications provide a backup supply to the cockpit floodlight above the standby instruments.

Safety Recommendation 2007-066

The European Aviation Safety Agency should mandate the provision of a power supply for the standby instrument integral lighting which is independent of the aircraft's normal electrical power generating systems, on A320 family aircraft.

Safety Recommendation 2007-067

Airbus should conduct a study into the feasibility of automating the reconfiguration of the power supply to the AC Essential bus, in order to reduce the time taken to recover important aircraft systems on A320 family aircraft following the loss of the left electrical network.

In response to this Safety Recommendation, while it was at the draft stage, Airbus issued Service Bulletin SB A320-24-1120 in May 2007. This introduced Modification 37317 which provides automatic reconfiguration of the power supply to the AC ESS Bus in the event of AC BUS 1 failure.

Safety Recommendation 2007-069

Airbus, in conjunction with the Generator Control Unit (GCU) manufacturer Hamilton Sundstrand, should modify the A320 family GCUs to provide the capability to record intermittent faults and to reduce their susceptibility to false differential protection trips.

Safety Recommendation 2007-070

The International Civil Aviation Organisation should expedite the introduction of a standard for flight deck image recording, and should encourage member states to provide legal protection, similar to that for cockpit voice recordings, for such image recordings.

Safety Recommendation 2007-071

British Airways PLC should review the advice given to flight crew concerning aircraft Technical Log entries, where an Air Safety Report (ASR) is also raised, to ensure that the aircraft Technical Log fully records the details of serious incidents and to ensure, as far as possible, that ASRs are received by the Flight Operations Safety Department in a timely a manner, irrespective of where the ASR is raised.

AIRCRAFT ACCIDENT REPORT No 3/2008

This report was published on 12 February 2008 and is available on the AAIB Website www.aaib.gov.uk

REPORT ON THE ACCIDENT TO BRITISH AEROSPACE JETSTREAM 3202, G-BUVC AT WICK AIRPORT, CAITHNESS, SCOTLAND ON 3 OCTOBER 2006

Registered Owner and Operator:	Eastern Airways
Aircraft Type:	British Aerospace Jetstream 3202
Nationality:	British
Registration:	G-BUVC
Place of Accident:	Wick Airport, Caithness, Scotland
Date and Time:	3 October 2006 at 1621 hrs

Synopsis

The accident was notified to the Air Accidents Investigation Branch (AAIB) by Wick Air Traffic Control at 1800 hrs on 3 October 2006. The AAIB investigation team consisted of:

Mr A Simmons	Investigator-in-Charge
Mr M Ford	Flight Recorders
Mr P Hannant	Operations
Mr B McDermid	Engineering

The aircraft was on a scheduled flight from Aberdeen to Wick. It was the fourth sector of a six-sector day for the crew, during which there had been no significant delays. The crew flew the VOR/DME procedure for Runway 31, and became visual with the runway during the latter stages of the arc portion of the procedure. They configured the aircraft with the landing gear selected 'DOWN' and flaps set as required for the approach and landing. The commander, who was the Pilot Flying, flared the aircraft for touchdown at the normal height but as the aircraft continued to sink, he realised that the landing gear was not down. He carried out a go-around and, following a recycling of the landing gear, flew past the control tower. The controller confirmed that the landing gear was down and the aircraft diverted back to Aberdeen Airport where a safe landing was made. It was subsequently found that, during the go-around, the underside of the fuselage and the tips of the right propeller had contacted the runway surface.

The investigation found that contamination of the landing gear selector switch points had acted as an electrical insulator preventing current flow to the landing gear lowering system and audible warning systems. The three green landing gear indicator lights, which are independent of this circuit, had functioned correctly. The crew had not checked the indication prior to landing and were therefore unaware that the landing gear was retracted.

The investigation identified the following causal factors:

1. Mechanical wear and arcing across one of the poles in the gear selection switch resulted in a piece of cupric oxide acting as an insulator across the pole which should have energised the gear extension circuit.
2. The flight crew did not identify that the landing gear was not down and locked by visually checking the landing gear green indicator lights.
3. Due to the failures associated with the gear selection switch, the flight crew received no audible warnings of the landing gear not being in the 'DOWN' position.

As a result of the investigation, four Safety Recommendations have been made. Two of these were made at an early stage of the investigation to the US Federal Aviation Administration.

Findings

1. The operating flight crew members were correctly licenced and qualified to conduct the flight.
2. The Company SOPs, which were based on the manufacturer's Flight Manual procedures, did not require monitoring or cross-checking of the gear position by the PF. This deficiency has been subsequently rectified.
3. The failure of the landing gear to extend and the indicator lights to illuminate was not observed by the crew, and no audible warning was received.
4. The PF sensed that the aircraft was descending below the normal gear down position during the landing and expeditiously initiated a go-around minimising the damage to the aircraft.
5. The cabin attendant heard a scraping noise as the aircraft touched down at Wick, but this information was not passed to the flight crew. The briefing procedure has been amended to require the flight crew to question the cabin crew regarding any observed anomalies.
6. The crew were unaware of any damage to the aircraft when they decided to return to Aberdeen.
7. The landing gear did not extend because of damage to the contacts of one pole of the selector switch, caused by electrical arcing.
8. The remaining poles of the landing gear selector switch functioned correctly, inhibiting the warning horn and the TAWS audible warning.
9. The Radio Altimeter type had been incorrectly set in the TAWS, causing an incorrect predictive response from this system. However this had no bearing on this accident.

Safety Recommendations

The following Safety Recommendations were made to the FAA during the investigation:

Safety Recommendation 2006-135

It is recommended that the US Federal Aviation Administration review the technical data supporting

STC SA3020AT for the introduction of the Sandel ST3400 TAWS to ensure that the post installation test is sufficient to validate the full range of inputs into the system.

Response: The FAA responded that EMTEQ had changed the ground test procedure to fully test the system for proper configuration and had implemented corrective action to retest aircraft in service for possible configuration errors. EMTEQ issued mandatory Service Letter No 2-25975-1-1 on 1 January 2007 to require these corrective actions.

Safety Recommendation 2006-136

It is recommended that the US Federal Aviation Administration take immediate action to ensure that aircraft equipped with the Sandel ST3400 TAWS have the correct radio altimeter type set and that the system is tested to ensure that the radio altimeter signal is correct over the operating range specified in the Sandel ST3400 installation manual.

Response: The FAA responded that a programme of testing seventy five modified Jetstream 3202 aircraft was under way and that, at that time, no other incorrectly configured aircraft had been found.

The following additional Safety Recommendations are made:

Safety Recommendation 2007-079

It is recommended that BAE Systems amend the generic procedures contained in the manufacturer's Flight Manual to include confirmation by both PF and PNF that the landing gear handle is selected down and that three green indicator lights are illuminated. They should encourage operators of the Jetstream aircraft to adopt the revised procedure in their own Standard Operating Procedures.

Safety Recommendation 2007-080

It is recommended that BAE Systems should review the safety analysis for the Jetstream 32 landing gear system to include cases where the gear selector lever can be moved to the 'DOWN' position with the landing gear remaining retracted and the audible warning inhibited.

FORMAL AIRCRAFT ACCIDENT REPORTS
ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2007

2/2007 Boeing 777-236, G-YMME
on departure from
London Heathrow Airport
on 10 June 2004.

Published March 2007.

3/2007 Piper PA-23-250 Aztec, N444DA
1 nm north of South Caicos Airport,
Turks and Caicos Islands, Caribbean
on 26 December 2005.

Published May 2007.

4/2007 Airbus A340-642, G-VATL
en-route from Hong Kong to
London Heathrow
on 8 February 2005.

Published September 2007.

5/2007 Airbus A321-231, G-MEDG
during an approach to Khartoum
Airport, Sudan
on 11 March 2005.

Published December 2007.

6/2007 Airbus A320-211, JY-JAR
at Leeds Bradford Airport
on 18 May 2005.

Published December 2007.

7/2007 Airbus A310-304, F-OJHI
on approach to Birmingham
International Airport
on 23 February 2006.

Published December 2007.

2008

1/2008 Bombardier CL600-2B16 Challenger
604, VP-BJM
8 nm west of Midhurst VOR, West
Sussex
11 November 2005

Published January 2008.

3/2008 British Aerospace Jetstream 3202,
G-BUVC
at Wick Aerodrome, Caithness, Scotland
on 3 October 2006.

Published February 2008.

2/2008 Airbus A319-131, G-EUOB
during the climb after departure from
London Heathrow Airport
on 22 October 2005

Published January 2008.

AAIB Reports are available on the Internet
http://www.aaib.gov.uk