INCIDENT

Aircraft Type and Registration:	Avro 146-RJ100, G-JEAV (and others and Embraer 145)
No & Type of Engines:	4 Lycoming ALF502R-5 turbofan engines
Year of Manufacture:	1986
Date & Time (UTC):	17 January 2006 at 1600 hrs
Location:	Between Southampton and Manchester
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 5 Passengers - 37
Injuries:	None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	N/A
Commander's Flying Experience:	N/A
Information Source:	Aircraft Accident Report Forms submitted by pilots and subsequent enquires by the AAIB

Synopsis

AAIB Bulletin 4/2006, published in April 2006, documented numerous occurrences of flight control restrictions experienced during the winter of 2004/2005 on aircraft with non-powered flying controls. These events were believed to have been caused by the freezing of the rehydrated residues of thickened de/anti-icing fluids, that had accumulated in the aerodynamically 'quiet' areas of the elevator and aileron controls. The bulletin described the contributory factors involved and made safety recommendations, addressed to the Joint Aviation Authorities (JAA) and European Aviation Safety Agency (EASA).

In the winter of 2005/2006, many more events of control restrictions were reported to the AAIB, by UK operators of Avro 146/RJ and Embraer 145 aircraft types. These events are presented in this report, which re-states the safety recommendations made in AAIB Bulletin 4/2006.

The AAIB has repeatedly expressed its concerns to the UK CAA, the JAA and EASA, that effective measures to address the airworthiness concerns posed by the residues of thickened de/anti-icing fluid have yet to be implemented.

Flight control restriction events - winter 2005/2006

The most recent control restriction events reported to the AAIB are described in the attached tables. Table 1 presents the incidents to Avro 146/RJ aircraft and Table 2 the events to Embraer 145 aircraft.

	DATE	Aircraft Tail No./ Sector	INCIDENT DESCRIPTION	FINDINGS
1	27-Mar-06	G-JEAV Birmingham - Toulouse	During cruise at FL270, a/c was sluggish during an autopilot-controlled turn & failed to roll level out of the turn. 'AIL' warning caption appeared. On disconnecting autopilot, aileron controls were very stiff and resistant to movement, but the a/c remained controllable. Flight continued to destination & aileron controls became normal as conditions warmed. The takeoff and climb to FL150 were in wet conditions. AAIB File ref: EW/G2006/03/19	A/c had been parked on the ramp overnight, during which there had been significant rainfall. A glutinous opaque fluid was found in the control runs inside the wings after removing inspection panels. A/c had been previously de-iced on 22 March 2006.
2	27-Mar-06	G-JEAJ Southampton - Bergerac	Departed Southampton in rain (OAT +10 deg C). A/c climbed to FL270 with a/c & autopilot performing normally. A/c was accelerated to M 0.7 and on passing the French coastline the aileron trim caption illuminated for a short time. Later on when following an ATC instruction to change heading, the caption reappeared and the a/c failed to follow the flight director bars. When autopilot disconnected, ailerons were very stiff to operate. Aileron stiffness disappeared when descending through FL100.	
3	20-Feb-06	G-JEAY Southampton - Malaga	During cruise at FL270 with autopilot engaged, flight director gave a large right turn indication. When autopilot disconnected, a/c was found to be difficult to turn left & almost impossible to turn right. 'PAN' declared with request to route direct back to Southampton. A/c was descended into warmer air. Greater aileron control experienced from 4000 ft in the descent, but controls seemed very sloppy. AAIB File ref: EW/G2006/02/11.	Left & right ailerons inspected, panels 581 & 681AAB, 581/681ABB, 533 & 633AB, 533 & 633CB removed. Accumulations of de-icing fluid (rehydrated) found & removed on left & right ailerons beneath panels 581/681AAB & 581/681ABB.
4	15-Feb-06	G-JEAJ Southampton - Edinburgh	Takeoff & climb were uneventful. In level flight at FL140, with autopilot engaged, a/c started to sink (-300 ft/min) & then climbed at 500 ft/min. The autopilot was disengaged at FL142 and FL140 was regained, but it was noted that the controls were stiff. Control column & elevator trim wheel became 'locked'. Slight stiffness of aileron controls also noted. 'PAN' declared for 'no pitch control'. A/c was descended to FL60-70 by gentle reduction of engine power. At FL60 (OAT +3 deg C), controls gradually returned to normal. AAIB File ref: EW/G2006/02/05.	A/c had been parked outside in heavy rain overnight. On stand at Edinburgh de-icing fluid seen oozing from air-conditioning bay hatch, although the a/c had not been de-iced that day.
5	04-Feb-06	G-CFAA Madrid - Birmingham	Autopilot was disconnected at FL210 & a/c flown manually for an approach to Birmingham. Manual trim felt unusually stiff but the trim motor operated satisfactorily. Manual trim returned to normal on final approach. AAIB File ref: EW/G2006/02/16.	A/c Technical Log showed that the a/c had recently been de-iced with Type IV de-icing fluid.
6	20-Jan-06	G-MANS Inverness - London Gatwick	In cruise at FL270, aileron trim warning occurred in turn at a waypoint. Manual roll control was available, but abnormally heavy in both directions. No further aileron trim warnings after autopilot re-engaged. Aileron controls were rechecked when passing through 0 deg C level around 6,000 ft, when roll control was normal to the right, but still heavy to the left. Aileron control forces had returned to normal by 4,000 ft. AAIB File ref: EW/G2006/01/23.	

TABLE 1: Winter 2005/2006 Flight Control Restriction Events - Avro 146/RJ

	DATE	Aircraft Tail No./ Sector	INCIDENT DESCRIPTIONS	FINDINGS
7	17-Jan-06	G-JEAV Southampton - Manchester	On reaching FL220, altitude was captured & locked. Flight director however continued to show a fly-up indication, which was increasing. A/c then tried to climb to follow flight director. Autopilot was disconnected & a/c flown manually. A/c wanted to pitch up & when electric trim used to compensate, on every occasion the trim returned to its original position. The control column could be held forward using about three times the normal force, but the trim could not be adjusted to hold it there. Controls returned to normal in the descent. AAIB File ref: EW/G2006/01/14.	A/c was removed from service for investigation, which involved removing the elevators. When elevator trim rod fairings removed, significant accumulations of residues of thickened de/anti-icing fluid residues were found (Figure 1). In response to these findings, the a/c manufacturer issued All Operator Message 06/001V. The operator of G-JEAV instigated a fleet-wide check to remove trim tab fairings and inspect for and remove accumulations of fluid residues.
8	17-Jan-06	G-OZRH Paris CDG - Birmingham	During cruise at FL200 elevator trim began pitching a/c up & down, causing a slow but pronounced pitch oscillation. 'ELEV TRIM' caption appeared & trim movement confirmed on trim indicator. Oscillations continued, reaching a max. of +/-300 ft/min. Due to heavy windscreen icing, ice contamination of elevator circuit suspected & descent requested. 'PAN' declared as a/c not maintaining stable level flight. Speed reduced & autopilot disconnected. Strong resistance felt when attempting to move trim wheel. In descent a/c behaved normally & autopilot re-engaged. Oscillations returned when a/c leveled, so a/c flown manually. At FL130 in clear air & OAT 0 deg C, autopilot re-engaged with no oscillations. 'PAN' cancelled & landing uneventful. AAIB File ref: EW/G2006/01/13.	Significant quantities of de/anti-icing fluid residues found under elevator trim tab control rod fairings.
9	08-Jan-06	G-JEAV Bordeaux - Southampton	Takeoff was normal, with initial climb in icing conditions with moderate/heavy rain. In the autopilot-controlled climb in IAS mode, the a/c began to oscillate in pitch, causing the rate of climb to reduce to less than 500 ft/min. Autopilot was disengaged and both crew members expected abnormally stiff elevator controls, which was the case. Although elevator control was stiff, a/c remained controllable and climb was continued to FL280. Flight was continued to destination, with elevator control returning to normal at approximately 5,000 ft altitude. AAIB File ref: EW/G2006/01/07.	When a/c inspected at Southampton, 'significant' quantities of de/anti-icing fluid residues found. Elevator trim tab control rods found coated with fluid residues. See also item 5 above.
10	08-Jan-06	G-JEAV Southampton - Bordeaux	In an autopilot-controlled climb, the a/c had overshot the assigned FL270 by 100 ft, at which point the autopilot was disconnected & manual control assumed in an attempt to level off. The a/c felt 'tail heavy' & required the strength of both pilots pushing on the control column to level off, but the cleared level was still busted by 250-300 ft. Elevator trim position did not appear grossly abnormal; manual flying was very difficult, but the a/c was controllable. 'PAN' declared. Radar vectors requested for long final to configure early for landing. At approx. 5,000 ft elevator forces were normal again. AAIB File ref: EW/G2006/01/05.	A/c tail inspected at Bordeaux by an engineer using a 'cherry picker' hoist. Small patches of de-icing fluid residue found externally on control surfaces. Residues were cleaned off and further inspections requested on return to Southampton. See also item 5 above.
11	08-Jan-06	G-JEAJ Chambery - Southampton	Aileron trim warning occurred 15 mins into the cruise at FL270 (OAT -40 deg C) in clear conditions. The flight director commanded a right turn on passing over a waypoint but the autopilot did not respond & the a/c remained wings level. The autopilot was disconnected & a right turn attempted manually. The ailerons were found to be very stiff/almost jammed to the right, but a small amount of right roll was achieved (10 deg bank). The ailerons were also very heavy to the left. A descent was requested and immediately approved. A/c was descended to FL 230 (OAT -23 deg C), where the ailerons freed up, with no further warnings/incidents. Light icing experienced in the climb, but no icing at time of incident. AAIB File ref: EW/G2006/01/06.	Ailerons & elevators inspected for de-icing/anti-icing residue. Minor accumulations noted in aileron void areas. Ailerons & elevators & void areas flushed through with hot de-ice 25/75 mixture to remove residues.

TABLE 1 (cont.): Winter 2005/2006 Flight Control Restriction Events - Avro 146/RJ

	DATE	Aircraft Tail No./ Sector	INCIDENT DESCRIPTION	FINDINGS
1	15-Feb-06	G-EMBK Manchester - Edinburgh	A/c began oscillating in pitch shortly after establishing in the cruise at FL200. On disconnecting the autopilot, it was found that the control column could not be moved fore & aft. Memory drill for jammed elevator actioned, but both control columns remained immovable. A/c could be controlled in pitch by using the pitch trim control. 'PAN' call made to ATC, with a request for a gentle, continuous descent into Edinburgh. During the descent, some column movement became available & a landing was made with 22 degrees flap in accordance with QRH procedure EAP-87 - Jammed Elevator. Both control columns found to be fully free after landing. AAIB File ref: EW/G2006/02/04.	
2	15-Feb-06	G-EMBF Manchester - Dusseldorf	After level off at FL310 with autopilot engaged, a/c started porpoising with a rate of climb & descent of 1000 ft/min. Autopilot was disconnected, aircraft re-trimmed & autopilot re-engaged, after which the a/c began porpoising again & over a period of 1 ½ minutes reached a rate of climb & descent of 1,500 ft/min. When autopilot disconnected again it was noticed that there was only approximately one inch forward & aft movement of the control column. Elevator trim operation was normal. QRH procedure EAP-87 - Jammed Elevator consulted for approach & landing info, but it was decided not to disconnect the elevators. A/c was descended to FL280, as no longer RVSM compliant. Flight continued to destination using elevator trim to control pitch & further descent carried out into warmer air. Control column fwd & aft movement began to increase to a maximum of four inches fwd & aft as OAT rose above 0 deg C. Approach & landing were uneventful. AAIB File ref: EW/G2006/02/04.	When a/c inspected on stand, re-hydrated anti-icing fluid found in gaps between stabiliser & elevator control surfaces. The operator has since increased the frequency of inspection for fluid residues on the Embraer 145 fleet.

TABLE 2: Winter 2005/2006 Flight Control Restriction Events - Embraer 145

The symptoms reported are similar, in many of these cases, to those described in AAIB Bulletin 4/2006, which lists the control restriction events reported in the winter 2004/2005 period.

The AAIB had previously highlighted the problems caused by thickened fluid residues in AAIB Bulletins 12/2003 and 2/2004 published on 11 December 2003 and 5 February 2004, respectively.

Following the recent discovery of accumulations of thickened de/anti-icing fluid residues under the elevator trim tab rod fairings on Avro 146/RJ aircraft, Figure 1, the aircraft manufacturer issued an All Operators Message (AOM) 06/001V on 20 January 2006, recommending that operators inspect the area for fluid residues. A copy of the AOM was included in AAIB Bulletin 4/2006.

Figure 1

G-JEAV Left-hand elevator trim tab control rods, with fairing removed. Residues shown four minutes after re-hydration by water mist.

ERA Winter Operations Workshop

Recognising the lack of effective progress made by the industry in solving the problems posed by the rehydrated residues of thickened de/anti-icing fluids, the European Regions Airline Association (ERA) convened a Winter Operations Workshop on 11-12 April 2006. The purpose of the workshop was to find solutions to the safety problems caused by the thickened fluid residues and inconsistent standards of de/anti-icing service provision within Europe. The attendees included airline operators, aircraft manufacturers, JAA, EASA, de/anti-icing fluid manufacturers, de/anti-icing service providers, national airworthiness authorities and accident investigation authorities, including the AAIB.

The workshop reached consensus on a number of specific goals which needed to be achieved in order to ensure flight safety. A copy of the ERA newsletter describing these actions is attached to this bulletin for reference, Figure 2.

Discussion

The numerous incidents in the winters of 2004/2005 and 2005/2006 in the UK, of flight control restrictions believed to have been caused by the freezing of residues of thickened de/anti-icing fluids, show that this problem still has not been effectively addressed by the industry. This is a matter of concern, given that the potential dangers posed by such residues have been publicised by the AAIB, and other organisations. Experience has shown that the currently available thickened de-icing fluids, with their rehydratable residues, are not practically suited for use on aircraft with non-powered flight controls and continue to pose a hazard to flight safety through their ability to cause flight control restrictions.

era
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news

Experts unite to improve winter aviation safety

20/04/2006

Aircraft de/anti-icing experts are working together to plan vital safety improvements in this unregulated area.

A unique workshop arranged by the European Regions Airline Association (ERA), the Joint Aviation Authorities (JAA) and Swiss International Air Lines saw 65 delegates representing airlines, aircraft manufacturers, service providers, national authorities, the European Aviation Safety Agency (EASA), JAA, accident investigators, fluid manufacturers, flight and cabin crew unions and auditors meet in Basel, Switzerland, from 11-12 April.

The workshop set out to find solutions to the safety problems caused by thickened fluid residues and inconsistent standards of service provision within Europe.

Following detailed discussions the following goals were unanimously agreed upon:

- Type I de-icing fluid should be more readily available at more airports;
- Operators should be able to receive on demand the service they request, including two-step de/anti-icing;
- Service providers should be licensed and overseen by a regulatory body;
- De/anti-icing personnel should be licensed by a regulatory body;
- Consideration should be given to the certification of de/anti-icing products;
- A greater amount of independent research and development should be conducted into the behaviour of thickened fluids and the prevention of residue formation.

New UK Air Accident Investigation Board (AAIB) recommendations, presented at the workshop, clearly indicate it is time regulatory bodies within Europe took some responsibility and helped the industry by developing suitable legislative solutions. Operators have previously developed their own detailed and costly maintenance programmes to mitigate against the risks that exist from re-hydrating fluid residues. The problems, which include the freezing of flight control surfaces, have existed for more than nine years and delegates at the workshop were adamant that action needs to be taken immediately to reduce the likelihood of an accident.

ERA will use the workshop consensus to encourage national authorities to combine knowledge and resources and set a timetable for addressing these action points. ERA does not consider inaction to be an acceptable option.

NOTES FOR EDITORS
Founded in 1980, ERA is the recognised representative body for intra-European air transport. It currently represents 68 airlines and over 150 Associate and Affiliate members, including most of the principal airframe and engine manufacturers, suppliers and airports from throughout the area. For further information, please contact: Steve Garrett, Manager Operations and Safety | Tel: +44 (0)1276 485552 | Fax: +44 (0)1276 857038

Figure 2

It remains the AAIB's view that Regulators introduce, without delay, requirements for the properties of de/anti-icing fluids and how they are applied to aircraft, to ensure that acceptable standards of quality and safety are maintained.

Safety Recommendations

Flight control restrictions, on aircraft with non-powered flying controls, caused by the re-hydrated residues of thickened de/anti-icing fluids have been well documented in previous AAIB Bulletins. Despite this, recent events in the UK, in the winter of 2005/2006, have shown that the problem is still prevalent.

The safety recommendations issued by the AAIB in bulletin 4/2006 were intended to encourage the European Regulatory Authorities to address the problem, highlighted in AAIB Bulletins 12/2003 and 2/2004. A satisfactory resolution has yet to be achieved, therefore these safety recommendations are re-stated as follows:

Safety Recommendation 2005-135

It is recommended, that the Joint Aviation Authorities, in consultation with the European Aviation Safety Agency, issue safety documentation to strongly encourage operators of aircraft with non-powered flight controls to use Type I de/anti-icing fluids, in preference to 'thickened' fluids, for de-icing.

Safety Recommendation 2005-136

It is recommended that where the use of 'thickened' de/anti-icing fluids is unavoidable, the Joint Aviation Authorities, in consultation with the European Aviation Safety Agency, ensure that operators of aircraft with non-powered flight controls who use such fluids, invoke controlled maintenance procedures for the frequent inspection for accumulations of fluid residues and their removal.

Safety Recommendation 2005-137

It is recommended that the European Aviation Safety Agency introduce certification requirements relating to de/anti-icing fluids for use on aircraft with both powered and non-powered flight controls.

Safety Recommendation 2005-148

It is recommended that prior to the European Aviation Safety Agency assuming responsibility for operational matters within Europe, they consider the future need for the training and licencing of companies who provide a de/anti-icing service, so that anti-icing fluids are applied in an appropriate manner on all aircraft types, but specifically to ensure that the entry of such fluids into flight control mechanisms and control surfaces is minimised.