The Dutch Safety Board

Occurrence #: 2005065 **Classification: Serious incident**

FACTUAL INFORMATION

Date of the occurrence:	16-05-2005	POB flight crew:	2
Place of occurrence:	Dutch airspace	POB cabin crew:	2
Aircraft registration:	PH-KZR	POB passengers:	68
Airline company:	KLM Cityhopper	Injuries:	None
Aircraft model:	Fokker F28 Mk 070		
Type of aircraft:	Passenger aircraft		
Type of flight:	Scheduled airline flight		
Phase of operation:	En route	Lighting conditions:	Daylight
Damage to aircraft:	None		

Investigation & Analysis

The aircraft was en route from Torp (Norway) to Amsterdam. The crew reported that during descent into Amsterdam Airport Schiphol aileron control was lost, no left turn was possible. During final approach the crew noticed that partial aileron control regained. The landing itself was uneventful. All occupants safely disembarked the aircraft.

The Fokker F28 series have powered flight controls. The aileron actuators are situated close to the aileron. The yoke inputs are transferred to the actuators by cables. Because of two incidents with heavy aileron movement within the airline less than two months before the occurrence, the attention was drawn to the aileron pulleys in the wheel bay. During the investigation of the earlier incidents those pulleys were found covered with de-icing fluid residue and with worn bearings. On the left-hand aileron pulley a gel-like residue of 'de-icing' fluid had accumulated. The residue found is highly hygroscopic and it was suspected that blocking of the aileron mechanism was caused by freezing of this residue. On the right-hand aileron pulley no residue was found. The problem could not be reproduced on the ground. It was established that there was a gap in the wing to fuselage fairing (seal), which enabled de-icing/anti-icing fluid to seep through, onto the aileron pulley system located in the wheel bay. This resulted in an Airworthiness Directive (AD NL 2005-13, issued 17 October 2005) requiring an inspection of the wing to fuselage fairings above the main landing gear for all Fokker F28 Mk70/100 with a latest compliance date of 1 November 2006.

According to the airline company the PH-KZR was not 'de-iced' on the day of the occurrence. The last time was 25 days before on 21 April 2005 with Type I fluid. In the period from 1 February through 5 March 2005 the PH-KZR was de-iced/anti-iced almost every day, sometimes twice a day. In the first week of March 2005 severe winter conditions prevailed and PH-KZR was treated 9 times in 5 days, the majority at Amsterdam Airport Schiphol with 100% Type II.

At the time of the occurrence the airline company involved applied one inspection and cleaning per winter to be performed as part of scheduled maintenance check in the period October-May. The prescribed inspection and cleaning task contains, among others, an inspection of the aileron pulley system in the wheel bay. For the PH-KZR this inspection was last executed on 19 April 2005 four weeks before the occurrence flight. Because of the relation with the local circumstances, the inspection interval is left to the operator. Until the winter of 2004/2005 no similar incidents were reported.
Following a similar occurrence in winter 2005/2006 (ref. PH-KZA, 29 March 2006) the scope of the investigation was expanded to focus on de-icing/anti-icing strategy, spraying methods, thickened fluids in use and parts other than the aileron pulley system (aileron actuator, stabilizer).
During the investigation it was discovered that these occurrences are not limited to this airline or the type of aircraft. Due to several previous reports concerning problems with the elevator control on

aircraft with non-powered flying controls like Avro 146-RJ100, DC-9/ MD80 and DHC-8, the (British) Air Accidents Investigation Branch (AAIB) did extensive research into aircraft icing, among others including freezing of 'de-icing' fluid residue. The Dutch Safety Board considers the reports and recommendations issued by the AAIB, the Joint Aviation Authorities (JAA), the Association of European Airlines (AEA) and the European Regions Airline Association (ERA) of importance for this occurrence (see references below).

In this paragraph a brief description is given of aircraft 'de-icing' and 'anti-icing'. 'De-icing' and 'anti-icing' are applied by spraying special fluids on the aero dynamical critical areas of an aircraft to clear and keep them clear of snow and/or ice. Several types of 'de- and anti-icing' fluids exist each with its own characteristics. These fluids consist mainly of a mixture of glycol and water. The main differences between the fluids are the viscosity (and thus holdover time) and residue characteristics. Unthickened fluid (ISO Type I) will run off surfaces more readily. As these fluids do not contain thickeners they do not leave significant residues but have a limited holdover time. Thickened fluids like ISO Type II, Type III and Type IV contain thickening agents and other chemicals that are not present in Type I fluids. The purpose of the agents is to encourage the fluid to remain longer on the treated aircraft surfaces to extend the holdover time. Ideally all fluid will flow off the airframe during acceleration at take-off. However, due to aircraft specific aerodynamic effects this is not always the case. Viscous "anti-icing" fluid may remain on external surfaces (including critical areas) and "aerodynamically quiet areas" such as the gaps between wing/tail plane, aileron/elevator and control surface trim tabs. Because it is applied under high pressure, fluid can also infiltrate inside the elevator and trim tab structures. When exposed to dry air for long periods, the glycol and water will evaporate from the fluid. This generally leaves the thickening agents and other chemicals in a dry powdery form. When these dry residues are exposed to moisture, such as rain or high humidity, the chemicals absorb the water/moisture and expand into a colorless gel-like substance. This gel residue can swell to many times its original volume and will freeze at temperatures below zero. If the gel is frozen within the gaps between control surfaces, then certainly for non-powered control systems, these control surfaces may be difficult or impossible to move from the cockpit until the gel melts in warmer air. Similarly, gel that freezes inside the airframe can interfere with control systems and have the same effect.

On the majority of European airports normally the single-phase 'de-icing' procedure with Type II or Type IV fluid is applied. It is understood that operators in North America prefer to use a two phase 'de-icing' procedure, with an initial application of Type I fluid, followed by the application of a thickened fluid to 'anti-ice', if required. In the USA and in Canada few reports indicate problems with 'de-icing' fluid residue and this is mainly attributed to the use of the two-phase 'de-icing' procedure. Both the JAA as well as the AEA recommend to use the two-phase 'de-icing' procedure. The problem however is a limited availability of Type I fluid on European airports. To avoid problems a thorough and regular inspection and, if necessary, cleaning are required of all critical areas.

Following the 2005/2006 incidents the involved airline company changed its maintenance practices to inspect for 'de-icing/anti-icing' fluid residues. Additional areas for inspection and cleaning were defined and the frequency was increased from once per winter season to once per week (critical items) or once per A-check.

Several meetings and workshops regarding the subject were held during the past years. Following is a summary of initiatives which, if implemented, would help address the problem of fluid residues:

- Minimizing the use of preventative "anti-icing" with thickened fluids;
- Where possible, use of Type I fluids for "de-icing";
- Exploring the possibility of greater availability of Type I fluids at operator's hub stations;
- Seeking assistance from the fluid manufacturers on cleaning/solvents and the use of residue identification dye.

The German Bundesstelle für Flugunfalluntersuchung (BFU) has reviewed the relation between de-icing residu and control problems in the investigation of a serious incident. The report is attached (Attachment 1)

References:

- *AAIB Bulletin: 4/2006, Avro 146-RJ100, G-CFAC and others*, www.aaib.dft.gov.uk/home/index.cfm.
- *JAA SIC No.2, 15 September 2005, Ground de/anti-icing of Aeroplanes*, http://www.jaa.nl/index.html.
- *AEA Publication: Recommendations for De-Icing/Anti-Icing of Aircraft on the Ground,* http://www.aea.be/.
- *ERA,* http://www.eraa.org/.