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Aircraft Accident Investigation Bureau AAIB

Final Report No. 2016

by the Aircraft Accident Investigation Bureau

concerning the serious incident

involving aircraft ATR 42-320, registration HB-AFC
operated by the FARNAIR company, flight FAT6932

on 29 March 2006

at Geneva airport

Ursachen

Der schwere Vorfall ist darauf zurückzuführen, dass es zu einem Brandbeginn gekommen ist, verursacht durch einen Kurzschluss aufgrund von mehreren Montagefehlern.

General information on this report

This report contains the AAIB's conclusions on the circumstances and causes of the serious incident which is the subject of the investigation.

In accordance with article 3.1 of the 9th Edition, applicable since 1st November 2001, of the Annex 13 of the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the French language

All times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the accident, Central European Summer Time (CEST) applied as *local time* (LT) in Switzerland. The relation between LT, CEST and UTC is:
LT = CEST = UTC + 2 h.

For reasons of protection of privacy, the masculine form is used in this report for all natural persons, regardless of their gender.

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Final report

| | |
|-------------------------|---|
| Owner | FARNAIR Switzerland AG, 4030 Basel, Switzerland |
| Operator | FARNAIR Switzerland AG, 4030 Basel, Switzerland |
| Aircraft type | ATR 42-320 |
| Country of registration | Switzerland |
| Registration | HB-AFC |
| Location | Geneva airport |
| Date and time | 29 March 2006, 04:01 UTC |

Synopsis

When they were on final approach on ILS 23 at Geneva airport, the crew of ATR 42-320 on cargo flight FAT6932 declared an emergency situation to air traffic control (ATC) because of a fire in the cockpit. Despite this situation the aircraft was able to land normally and vacate the runway via rapid exit taxiway CHARLIE, on which it was forced to stop. The co-pilot reported the virtually total loss of all onboard systems to the controller and that they were no longer able to taxi on the ground. The airport safety service (SSA), already on the spot, took charge of the aircraft and asked for the engines to be shut down. The fire on board lasted for only a few seconds and external intervention was not necessary to fight the fire.

Investigation

The incident was notified to the Aircraft Accident Investigation Bureau at 04:10 UTC; an investigator went to Geneva Airport at about 05:00 UTC and talked to senior SSA officials and to the flight crew of FAT6932. The technical investigation was conducted in collaboration with one of the aircraft manufacturer's systems specialists, who arrived on the spot on the afternoon of the same day.

The serious incident is due to an incipient fire caused by a short-circuit following several assembly defects.

1 Factual information

1.1 History of the flight

1.1.1 Preliminary remarks

The history of the flight was reconstructed using the transcription of the radio-telephone communications between the flight crew of flight FAT6932 and the Geneva control tower (Geneva TWR), along with that of the cockpit voice recorder (CVR). It is based on the statements of the pilots and the report of the aerodrome controller on duty at the time of the incident. The elements provided by the flight data recorder (FDR) enabled the aircraft's movements to be reconstructed, particularly in relation to all the phases of the ILS (instrument landing system) approach on runway 23.

1.1.2 The flight preceding the flight involved in the incident

On the day before the incident, ATR 42-320, registration HB-AFC, was on commercial IFR cargo flight FAT6931 from Geneva (LSGG) to Cologne-Bonn (EDDK), where it landed at 20:29 UTC. In accordance with this night flight service, the flight crew remained in place awaiting the departure of the return flight FAT6932, which was scheduled to land in Geneva on 29 March 2006 at 04:00 UTC.

1.1.3 The incident flight

Loading of the 3850 kg payload onto cargo flight FAT6932 from Cologne-Bonn to Geneva was completed at 02:11 UTC and the doors were closed at 02:18 UTC.

The aircraft took off at 02:27 UTC from runway 32R and followed the standard instrument departure (SID) "NOR1B". The co-pilot was pilot flying (PF) and the commander was pilot non flying (PNF).

The flight's progress was normal; the aircraft's cruising altitude was flight level FL 190. Shortly before starting the descent to Geneva, it entered an area of cloud and the flight crew switched on the propeller de-icing system. In his statement, the commander reported that instrument meteorological conditions (IMC) and slight turbulence prevailed from flight level FL 150 down to an altitude of approximately 4000 feet.

Flight FAT6932 was cleared by the Geneva INI North Sector radar controller to adopt a heading direction waypoint DINIG, for standard instrument arrival route (STAR) "DINIG 3A". During the descent, it was transferred to approach control which guided it using vectors to intercept the ILS 23 approach. Flight FAT6932 was slightly ahead of its scheduled arrival time and the flight crew decided to reduce speed in order not to land before 06:00 LT, the airport's opening time.

At 03:55:08 UTC, the commander called Geneva tower and reported that they were established on the runway 23 ILS at 12 NM. The controller replied that he was number 1 and asked him to call back on short final. The aircraft was then flying at an indicated airspeed of 220 kt in clean configuration.

Throughout the descent and in particular during the approach, the pilots were vigilant with regard to the effects of the prevailing wintery meteorological conditions; in particular, they monitored wing icing conditions and chose to fly at speeds appropriate to the icing conditions until they landed ("icing conditions speed schedule").

At approximately 9 NM from the runway threshold, the flight crew reduced speed and at 165 kt IAS (indicated air speed) began to configure the aircraft for its final approach. At 4.5 NM, the aircraft was stabilised at an indicated air speed of 140 kt in landing configuration.

At 03:58:23 UTC, approximately 3 NM from the runway threshold, flight FAT6932 was cleared to land. The pilots had had the ground and the runway in sight for more than a minute.

At 03:59:02 UTC, the co-pilot reported that he was starting to reduce his speed to 125 kt and that he was going to manual. The acoustic autopilot disengage warning sounded and was followed by the commander stating that they had passed a radio altimeter height of 500 ft.

1.1.4 The incident

At 03:59:22 UTC, when the aircraft was at a height of approximately 450 feet, the cockpit voice recording contains a click, followed by a threefold sounding of the single note horn of the master caution warning. At the same time, the two pilots can be heard expressing a brief exclamation of surprise. In his statement, the co-pilot explains the cause of this manifestation of surprise: *"About 2 nautical miles before landing I heard something like the noise of a muffled explosion followed by a shower of sparks from the electrical panel behind me."*

The commander stated that he had experienced the same phenomenon and that he had made out a clear orange glow behind the circuit breaker panel located behind the co-pilot: *"There was a clear orange glow behind the circuit breaker panel."* He added that at 60 feet this glow had disappeared.

At 03:59:25 UTC, i.e. 3 seconds later, the co-pilot said to his colleague: *"OK, we continue..."*. The "triple click" acoustic warning indicating a degradation of the onboard system sounded shortly afterwards. The co-pilot remarked that he no longer had any readings from the control instruments and asked the commander to read out the speed.

During this phase of the flight, the radiotelephone communication frequency was occupied until 03:59:41 UTC due to contact between an aircraft which was on its final approach at 7.5 NM and the control tower.

At 03:59:42 UTC, the commander declared a state of emergency to ATC because of a fire in the cockpit: *"MAYDAY, MAYDAY, MAYDAY, FAT6932, we have fire in the cockpit, please send the trucks"*. The controller replied that the fire brigade had been alerted, confirmed the landing clearance and asked the pilot if he wanted to stop on the runway. The commander answered in the negative and stated that things seemed to be back in order but he wanted the fire brigade to remain on alert.

The co-pilot continued the approach visually, monitoring his speed on the emergency anemometer.

The aircraft touched down normally and shortly before the end of its landing roll the commander took over the controls in accordance with company procedures. He then stated that he did not have control over the nose wheel but was, however, able to vacate the runway via rapid access taxiway CHARLIE, on which he

was forced to stop. The co-pilot reported to the controller that they had lost virtually all their onboard systems and that they were no longer able to taxi on the ground.

The SSA was on the spot and took charge of the aircraft. Via the control tower, they asked the flight crew to shut down the engines. The commander complied, then asked the co-pilot to open the cargo hold door.

The fire on board lasted for only a few seconds and external intervention was not necessary to fight the fire. The fire brigade opened the two circuit breaker panels located behind the co-pilot's seat and as a safety measure discharged the contents of a CO₂ extinguisher into them.

1.2 Injuries to persons

| Injuries | Crew | Passengers | Total number of persons on board | Others |
|----------|------|------------|----------------------------------|--------|
| Fatal | --- | --- | --- | --- |
| Serious | --- | --- | --- | --- |
| Minor | --- | --- | --- | --- |
| None | 2 | --- | 2 | --- |
| Total | 2 | --- | 2 | --- |

1.3 Damage to aircraft

1.3.1 Damage caused by the fire (Annex 1)

Investigators found no damage in the compartments behind the two circuit breaker panels (122VU panel and 121VU upper panel) which are situated behind the co-pilot's seat.

A strand consisting of several hundred electrical wires, fixed by collars to a tubular structure, runs in the 120VU compartment located above the 121VU circuit breaker panel. Forty-eight of these exhibited damage caused by electrical arcing over a length of around 10 cm and over a surface area of approximately 20 cm²; the insulation had broken down and the metal had partially melted. Black traces left by combustion products covered the damaged area of the strand and also extended over some 15 centimetres of the spindle. The onboard systems linked to the damaged wires were not damaged.

The tubular support in contact with the burnt wires was damaged. At this point, the strand touched an earth cable which also exhibited traces of fire.

At one corner of the internal wall's surface of the 120VU compartment, there was a small area bearing trace of fire.

1.3.2 Onboard system malfunctions

The incident caused the following circuit breakers to trip:

| Circuit breaker panel | Circuit breakers |
|-------------------------------------|--|
| 21V6 | ENG 2 CTL SCU (C22) AHR5 2 PWR SPLY NORM (B 21) |
| 121VU | NOSE WHEEL STEERING: STEERING VALVE (E) |
| 122VU | COMP LT: FWD&AFT CARGO (L 22) ANTI ICING: CTL&IND PROP2 (P 12) MAIN ELECTRIC POWER DC GLU DC GEN 2 (Q20) |
| PRIMARY CB AC WILD | HORNS ANTI ICING POWER SUPPLY: R ELEV, R AIL, L AIL |
| PRIMARY CB MAIN ELEC POWER 124VU | DC GEN2 CONTL EXCN |

1.4 Other damage

Not applicable.

1.5 Personnel information

1.5.1 Commander

| | |
|--------------------------|--|
| Person | Dutch nationality, born 1964 |
| Crew duty time | Start of duty in Geneva 28.03.06 at 18:00 UTC End of duty in Geneva 29.03.06 at 04:32 UTC Flying duty period: 10:32 hours |
| Licence | Air transport pilot licence aeroplane (ATPL(A)) in accordance with joint aviation requirements (JAR), issued by the Civil Aviation Authority Netherlands |
| Ratings | Radiotelephony rating in English RT Instrument flying rating IR-ME (A) Rating type ATR 42/72 PIC IFR/VFR, valid until 01.09.2006 |
| Medical certificate | Classes 1 and 2, shall wear corrective lenses and carry a spare set of spectacles |
| Last medical examination | 04.01.06 |

1.5.1.1 Flying experience

| | |
|------------------------------------|---------------|
| Total hours | 3822:00 hours |
| On type ATR 42 | 3561:00 hours |
| during the last 90 days | 106:40 hours |
| of which on type ATR 42 | 106:40 hours |
| Crew duty time during last 30 days | 154:17 hours |

| | | |
|------------|------------------------------------|---|
| 1.5.2 | Co-pilot | |
| | Person | Swiss nationality, born 1975 |
| | Crew duty time | Start of duty in Geneva 28.03.06 at 18:00 UTC End of duty in Geneva 29.03.06 at 04:32 UTC Flying duty period: 10:32 hours |
| | Licence | Commercial pilot licence CPL(A), in accordance with joint aviation requirements (JAR), issued by the FOCA, valid until 25.10.06 |
| | Ratings | International radiotelephony rating RTI (VFR/IFR) Night flying rating NIT (A) Instrument flying rating IFR (A) Rating type ATR 42/72 COPI IR, valid until 25.10.2006 |
| | Ratings to be extended | Single-engine piston aircraft SEP |
| | Medical certificate | Classes 1 and 2, without restriction |
| | Last medical examination | 24.05.05 |
| 1.5.2.1 | Flying experience | |
| | Total hours | 897:03 hours |
| | On type ATR 42 | 618:23 hours |
| | during the last 90 days | 96:54 hours |
| | of which on type ATR 42 | 96:54 hours |
| | Crew duty time during last 30 days | 80:18 hours |
| 1.6 | Aircraft information | |
| 1.6.1 | Aircraft | |
| | Registration | HB-AFC |
| | Aircraft type | ATR 42-320 |
| | Manufacturer | Aero International (Regional) |
| | Year of construction | 1988 |
| | Serial number | 087 |
| | Owner | Farnair Switzerland AG, 4030 Basel, Switzerland |
| | Operator | Farnair Switzerland AG, 4030 Basel, Switzerland |
| | Engines | Pratt & Whitney Canada Inc., PW121 |
| | Propellers | Hamilton-Sundstrand Corp., 14SF-5 |
| | Airframe flying hours | 19,949 hours |

| | |
|-------------------------------------|--|
| Number of airframe cycles (landing) | 26,372 hours |
| Airworthiness certificate | Issued by the Federal Office of Civil Aviation (FOCA) on 05.04.01, valid till further notice |
| Registration certificate | Issued by the FOCA on 23.02.04 |

1.6.2 Mass and centre of gravity

A cargo manifest and a mass/centre of gravity estimate were drawn up for flight FAT6932 on departure from Cologne-Bonn. The mass and centre of gravity values were within the permitted limits throughout the flight; the landing mass was calculated at 15,865 kg, a value close to the maximum landing mass (16,400 kg).

1.6.3 Maintenance of the aircraft

The aircraft technical log attests to the maintenance follow-up; all the faults indicated in it by pilots were dealt with and periodic checks were carried out within the prescribed periods. On departure on missions FAT6931/6932, the DDL (deferred defect list) contained no outstanding items.

1.6.4 Inspection of the 120VU compartment

The inspection of the compartment (120VU) in which the fire occurred revealed the following assembly faults and anomalies:

- an earth cable was fitted incorrectly. As a result, its lower terminal was in direct contact with the wiring strand, whereas a space of at least 12.5 mm (0.5 in) is required between these two items;
- the tubular support onto which the strand was tied was deformed; the routing of the bundle of wires which had been modified in this way no longer permitted compliance with the minimum separations required between the structure and other cables;
- the collars fixing the strand to the tubular structure were not tightened correctly;
- the damaged strand contained more electrical wires than the original one because of modifications resulting from application of service bulletins; its diameter had therefore increased.

1.7 Meteorological information

1.7.1 General

The information contained in sections 1.7.2 and 1.7.3 was supplied by Météo-Suisse.

1.7.2 General weather situation

Die Schweiz lag am Südrand zweier Tiefdruckgebiete über Skandinavien. Es herrschte eine mässige Südwestströmung im Einflussbereich einer Kaltfront.

Translation:

Switzerland was at the southern edge of two low-pressure areas centred over Scandinavia. A strong airflow from the south-west prevailed under the influence of a cold front.

1.7.3 Meteorological situation at the location and time of the accident

Local meteorological conditions:

| | |
|----------------------------|---|
| <i>Wolken</i> | <i>3-4/8 auf 2500 ft AMSL, 5-7/8 auf 3500 ft AMSL</i> |
| <i>Wetter</i> | <i>leichter Regen</i> |
| <i>Sicht</i> | <i>um 15 km</i> |
| <i>Wind</i> | <i>210° mit 8 kt, Böen bis 15 kt, variabel zwischen 150° und 240°</i> |
| <i>Temperatur/Taupunkt</i> | <i>6 °C / 3 °C</i> |
| <i>Luftdruck</i> | <i>LSZH 1014 hPa</i> |
| <i>Sonnenstand</i> | <i>Azimut 069°, Höhe -14° (unter dem Horizont)</i> |
| <i>Gefahren</i> | <i>Lokal mässige Vereisung über 4000 ft AMSL</i> |

Translation:

| | |
|-----------------------|---|
| Cloud cover | 3-4/8 at 2500 ft AMSL, 5-7/8 at 3500 ft AMSL |
| Precipitation | Light rain |
| Visibility | Approximately 15 km |
| Wind | 210° at 8 kt, gusting to 15 kt Variable between 150° and 240°. |
| Temperature/dew point | 6 °C / 3 °C |
| Barometric pressure | LSZH 1014 hPa |
| Position of the sun | Azimuth 069°, elevation -14° (below the horizon) |
| Hazards | Moderate icing above 4000 ft AMSL |

Regular aviation meteorological observation report (METAR):

METAR 290350Z 21008KT 9999 -RA SCT025 BKN035 06/04 Q1014 NOSIG=

The significant weather chart (SWC) for 29 March 2006 at 00:00 UTC indicated that three cloud zones overlapped above the Geneva region. They consisted mainly of cumulus and altocumulus extending up to flight level FL 160, with cumulonimbus included for the mist coming from the south. Moderate icing and turbulence were indicated.

1.8 Aids to navigation

The aid to navigation used during the approach was ILS 23 ISW, equipped with distance measuring equipment (DME).

| | |
|-----------------------|-----------------------------------|
| Aerial navigation aid | ILS23 LLZ CAT III |
| Geographical position | 46° 13' 29,4" N, 006° 05' 22,3" E |
| Frequency | 109.90 MHz ID ISW |

1.9 Communications

Following the distress message transmitted on short final by the commander of FAT6932, the aerodrome controller immediately activated the airport safety service (SSA) unit provided for this purpose. He was then immediately in contact with the senior intervention officer and gave him the information necessary for initial briefing of the emergency services. The airport fire brigade followed the landing of ATR 42 and took charge of it on the rapid access taxiway CHARLIE.

1.10 Aerodrome information

1.10.1 Runway equipment

The data concerning the runway at Geneva international airport are as follows:

A single runway 23/05 3900 x 50 m, reference elevation 1411 ft AMSL, geographical position 46°14'17"N, 006°06'32"E.

ILS23-LLZ CATIII / ILS05-LLZ CATI.

Runway 23 take off run available (TORA) 3900 m / landing distance available (LDA) 3900 m

Runway 05 TORA 3900 m / LDA 3570 m

1.10.2 Rescue and fire-fighting services

Geneva airport is equipped with category 9 fire-fighting resources according to Annexe 14 of the ICAO. The airport's professional fire brigade (aviation fire-fighters) is on duty 24 hours a day. In the event of an accident, the intervention forces are able to remain in permanent contact with the control tower and with the police thanks to the alarm centre and appropriate telecommunications equipment.

A paramedic section is integrated into the fire and rescue services; it is equipped with vehicles and qualified personnel and is also on duty 24 hours a day. The paramedic section has an advanced medical facility. It is permanently connected to the Emergency Health exchange 144.

The entirety of Geneva International Airport's emergency plan is integrated into the cantonal system known as OSIRIS (organisation for intervention in exceptional situations).

1.11 Flight recorders

The information provided by the cockpit voice recorder and flight data recorder was used in the course of the investigation.

1.11.1 Cockpit voice recorder

The duration of the recording is 31 minutes and 50 seconds and covers the part of the flight from making contact with the Geneva INI North sector controller up to a few minutes after opening of the cargo hold door. The quality of the recording is good.

1.11.2 Flight data recorder

The following parameters, among others, are recorded and legible for the flight phases from the end of cruising up to clearing the landing runway:

- indicated airspeed – IAS;
- radio altitude – RA;
- pressure-altitude;
- transmission state of the VHF1 and VHF2 (very high frequency) communication systems
- state of engagement of the autopilot;
- flap setting;
- values of the DC 1 and DC 2 currents.

At the time of the incident, the value of currents DC 1 and DC 2 went from average values of approximately 50 A to 100 A to pulses of 300 A and 1000 A respectively – values characteristic of short circuits.

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

The pilots stated that they had heard the noise of a muffled explosion followed by an intense shower of sparks from the circuit breaker panel located behind the co-pilot. The incandescent particles passed over his head and some of them fell on his thighs and left impact traces on his trousers. The commander saw a bright, intense orange glow through the gaps between the circuit breaker panels located on the rear right wall of the cockpit.

These descriptions indicate a shower of sparks following a short circuit in the wiring strand located in the 120VU compartment. Several circuit breakers tripped and the electrical fire lasted for only a few seconds.

1.15 Survival aspects

Electrical fires which occur accidentally onboard aircraft may have many origins. If, as is the case in this incident, it affects a large number of electrical wires, various onboard systems may be affected. The pilots stated that they had lost all information provided by their navigation instruments apart from the emergency instruments; continuation of the flight could not take place under normal operation but was not compromised.

The fire did not spread in the wiring strand; the safety systems which trip the circuit breakers in the event of a short circuit functioned and the fire ceased by itself.

Defence against fires of electrical origin is provided by the "ELEC SMOKE" checklist. At the time of the incident the aircraft was less than one minute from landing and this procedure was not implemented by the crew.

The airport safety service (SSA) reacted immediately to the alarm triggered by the controller and met the aircraft on landing. A medical team verified that the pilots were not affected by the incident.

1.16 Tests and research

On the day of the incident, an electrical systems specialist from the manufacturer began a detailed inspection of the place inside the aircraft where the short-circuit occurred and of the parts it affected. The assembly defects which were found, the damage caused by the fire and the results of his analysis were included in a visit report sent to the Aircraft Accident Investigation Bureau.

A few days later, the manufacturer produced Damage Assessment Report A/C 087 intended to serve as a guide to the aircraft repair work. In it, the damage and assembly faults are documented and described in detail. The damaged parts and wires in the wiring strand are listed, along with the onboard systems to be tested.

1.17 Organisational and management information

The FARNER AIR TRANSPORT AG (FAT) company was founded in 1984 and provides an air cargo service in central Europe. Later becoming the FARNAIR group, this company has been operating two ATR 42-320 type aircraft, among others, since December 2000.

In 2004, with the introduction of bilateral agreements between Switzerland and the European Union, FARNAIR was consolidated into two entities: FAT (FARNAIR Switzerland) and FAH (FARNAIR Hungary). In November of the same year, FARNAIR Switzerland became an EASA part 145 organisation authorised to carry out line and basic maintenance on Fokker F-27 and ATR 42/72 aircraft.

In 2006, FARNAIR Switzerland, based at Basle Airport, operated 17 aircraft for cargo transport, including 6 ATR 72-200 aircraft and one ATR 42-320.

1.18 Additional information

Not applicable.

1.19 Useful or effective investigation techniques

Not applicable.

2 Analysis

2.1 Technical aspects

2.1.1 Onset of the short-circuit

The assembly faults and the increase in the diameter of the strand of electrical wiring described in section 1.6.3 are the initial factors which slowly generated conditions favourable to the onset of a short-circuit.

The lower terminal of the earth cable was in direct contact with the badly clamped, and therefore insufficiently tightened, electrical wires of a strand which was bulkier than its original design and mounted on a deformed tubular support. Its compactness was thus reduced and there was sufficient play between the wires to allow friction between them and with the earth cable. This phenomenon caused a reduction in the dielectric properties of the insulation of wires touching the earth cable terminal. As a result of wear, this insulation broke down, allowing direct metal-to-metal contact between two conductors, which was the cause of the major short-circuit.

2.1.2 Development of the fire

The damage caused by the fire, described in section 1.3.1, is indicative of the development of a fire following a cascade process of electrical arcs giving rise to the phenomenon termed general conflagration: the first short-circuit results in vaporisation of the conducting metal, generating very high temperatures and pressures in its immediate vicinity. The heat resulting from this vaporisation and from the electrical arc itself then break down the insulation of adjacent wires, leaving them exposed and in contact with each other. There is then a progressive cascade of arcs and combustion between the wires in the strand, which only ceases when the overvoltage protection systems activate, i.e. the circuit-breakers trip. To human perception, this succession of short-circuits is virtually instantaneous.

Following the conflagration, the onboard systems supplied or controlled by the damaged wires were deprived of current; this explains the loss of the navigation instruments and nose wheel control instruments reported by the pilots.

In order to avoid any inflammation which might be initiated by the heat produced by accidental arcing, the ATR 42 is designed so that no inflammable material is located close to elements of electrical systems. The seat of fire which appeared in the strand of wires did not therefore spread and the fire did not propagate.

2.1.3 The shower of sparks

A build-up of arcs produces very high temperatures and pressures in their immediate vicinity which ignite the insulation of the wires ejecting fragments beyond the location at which the short-circuit occurs. The molten metal of the conductor is also projected in the same way. These incandescent particles have very little energy and generally do not cause materials used in the cockpit to catch fire.

2.2 Operational and human aspects

2.2.1 Management of the flight

The recording of the cockpit conversations reveals that the flight crew worked in a professional manner.

At the time of the incident, the effect of surprise was quickly overcome. Despite the destabilising event caused by the shower of sparks, the pilots remained calm. Under visual flight conditions, the decision to continue the approach without the main navigation instruments was appropriate. The emergency situation was declared very quickly, allowing the aerodrome controller to immediately alert the airport safety services (SSA).

3 Conclusions

3.1 Findings

3.1.1 Flight crew

- The pilots held valid flying licences.
- There are no indications that the pilots' health was affected at the time of the incident.

3.1.2 Technical aspects

- On departure on missions FAT6931/6932, the DDL (deferred defect list) contained no outstanding items.
- The mass and centre of gravity values were within the permitted limits throughout the flight.
- An earth cable was fitted incorrectly. Its lower terminal was therefore in direct contact with the strand of electrical wiring, whereas there should have been a space of at least 12.5 mm (0.5 in) between these two items.
- The tubular support to which the strand was mounted was deformed; the routing of the bundle of wires modified in this way no longer permitted compliance with the minimum separations required between the structure and other cables.
- The collars used to mount the strand to the tubular structure were not tightened sufficiently.
- The damaged strand contained more electrical wires than the original design because of modifications resulting from application of service bulletins; its diameter had therefore increased.
- It was not possible to determine the precise origin of the assembly defects.

3.2 Causes

The serious incident is due to an incipient fire caused by a short-circuit following several assembly defects.

4 Safety recommendations and measures taken since the serious incident

4.1 Measures taken since the serious incident

Following the incident, the manufacturer conducted an investigation among several ATR 42/72 operators to find out if other cases of incorrect assembly of the earth cable in the 120VU compartment existed. The results showed that several instances of this fault had been found.

On 14 September 2006, the European Aviation Safety Agency (EASA) issued an airworthiness directive (AD) requesting inspection before 31 December 2006 of all ATR 42/72 aircraft in which the risk of a short-circuit resulting from this assembly defect might exist (Annex 2). The details of this operation and of the measures to be taken if necessary are given in Service Bulletins Nos. ATR42-92-0012 and no. ATR72-92-1013.

Payerne, 8 April 2009

Aircraft Accident Investigation Bureau

This report contains the AAIB's conclusions on the circumstances and causes of the serious incident which is the subject of the investigation.

In accordance with article 3.1 of the 9th Edition, applicable since 1st November 2001, of the Annex 13 of the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

Annexes

Annexe 1: Wiring strand damaged by the fire



Annex 2: Airworthiness directive No.: 2006-0283

Avis d'émission d'une Directive de Navigabilité (AD)* par

l'EASA, European Aviation Safety Agency

l'autorité primaire d'un matériel étranger

Les examens ou modifications décrits ou rappelés ci-dessous sont impératifs. La non application des exigences contenues dans la Directive de Navigabilité citée ci-dessous entraîne l'inaptitude au vol de l'aéronef concerné.

(Envoi 20/2006 du 27 septembre 2006)

Directive de Navigabilité de l'EASA de référence 2006-0283

ATR

Avions ATR 42 et ATR 72

Génération électrique - Harnais électrique 120 VU - Inspection

S'agissant d'un avion de plus de 5,7 tonnes de MTOW, il n'est pas proposé de traduction de l'AD jointe.

Nota pour les exploitants et organismes d'entretien d'aéronefs inscrits au registre français :

Si l'AD jointe invite à un contact vers l'autorité primaire de l'AD, contacter le bureau concerné du département certification-produits de l'EASA.

Si pour l'exécution d'une tâche donnée, l'AD jointe se réfère à une qualification de personnel répondant à une réglementation nationale, il est possible de faire intervenir, pour cette tâche, du personnel de qualification équivalente acceptée dans l'Union Européenne.

Si l'AD jointe se réfère à une donnée de navigabilité ou une instruction pour le maintien de la navigabilité (Manuel de Vol, Manuel de Maintenance, ...) qui n'est pas celle approuvée ou pas celle en vigueur en France ou si l'AD jointe présente une difficulté d'application liée à sa spécificité nationale, exposer le problème auprès du département technique du GSAC (par courriel à "contact@gsac.fr" ou par fax au 01 46 90 48 48) ou auprès du bureau concerné du département certification-produits de l'EASA.

La recopie de cette AD peut avoir dégradé la définition du document présenté. En cas de difficulté à lire certains éléments de cette AD, se reporter à l'AD originale mise à disposition par l'autorité primaire de l'AD.

* Cette AD est exigible au titre du règlement Européen 1702/2003 ou de la Décision n° 2/2003 de l'EASA.

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| EASA | AIRWORTHINESS DIRECTIVE |
|  | <p>AD No.: 2006-0283</p> <p>Date: 14 September 2006</p> |
| No person may operate an aircraft to which an Airworthiness Directive applies, except in accordance with the requirements of that Airworthiness Directive unless otherwise agreed with the Authority of the State of Registry. | |
| Type Approval Holder's Name: ATR | Type/Model designation(s): ATR 42 and ATR 72 Aircraft |
| TCDS Number: EASA A.084 | |
| Foreign AD: Not applicable. | |
| Supersede: Not applicable. | |
| ATA 24 | Electrical Power - 120 VU Electrical Harness - Inspection |
| Manufacturer(s): | ATR, (formerly AEROSPATIALE - AERITALIA, AEROSPATIALE - ALENIA, AEROSPATIALE ATR - ALENIA, EADS ATR - ALENIA) |
| Applicability: | ATR 42-200, -300, -320, -400, -500, all serial numbers up to MSN 643 inclusive. ATR 72-101, -102, -201, -202, -211, -212, -212A, all serial numbers up to MSN 728 inclusive, except MSN 723 and 725. |
| Reason: | <p>Recently an ATR 42 suffered electrical arcing, causing the loss of some instruments and loss of one hydraulic circuit pressure due to a chafing between a bonding cable and electrical wires in the 120 VU. The investigations showed that:</p> <ul style="list-style-type: none"> • A tubular support had been deformed and therefore impaired the spacing among electrical harness, supports and cables; • Harness was not correctly attached; • The size of the harness was increased by addition of cables (for Service Bulletins (SB) or customer modifications embodiments); • The bonding cable was not correctly installed. <p>This Airworthiness Directive mandates an inspection of the ATR 42 & 72 fleet to identify and correct possible similar cases, which could lead to an unsafe condition.</p> |
| Effective Date: | 28 September 2006. |
| Compliance: | Before December 31 st , 2006, inspect the harness installation in the 120 VU and, if necessary, restore the conformity to the approved design, in accordance with the instructions given by Service Bulletin (SB) ATR42-92-0012 (for ATR 42 models) or SB ATR72-92-1013 (for ATR 72 models). |

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|--------------------|---|
| Ref. Publications: | ATR SB ATR42-92-0012 or SB ATR72-92-1013, as applicable, or later approved revisions. |
| Remarks: | <ol style="list-style-type: none"> 1. If requested and appropriately substantiated the responsible EASA manager for the related product has the authority to accept Alternative Methods of Compliance (AMOCs) for this AD. 2. This AD was posted as PAD 06-202 for consultation on 07 August 2006 with a comment period until 18 August 2006. No comments were received during the consultation period. 3. Enquiries regarding this Airworthiness Directive should be referred to the Airworthiness Directive Focal Point - Certification Directorate, EASA. E-mail: ADs@easa.europa.eu 4. For any question concerning the technical content of the requirements in this AD, please contact: ATR, Didier CAILHOL - Fax: +33 (0) 5 62 21 67 18 or E-mail: continued.airworthiness@atr.fr |