Airliner Evacuation due to Smoke in the Cockpit at Helsinki-Vantaa Airport on 30 June, 2020

Preliminary investigation report L2020-E1

SYNOPSIS

On 30 June 2020, pursuant to section 2 of the Safety Investigation Act (525/2011), the Safety Investigation Authority initiated a preliminary safety investigation of an incident that occurred earlier on the same day. Following the landing of an airliner on a scheduled flight, smoke was detected in the cockpit and the decision was made to evacuate the aircraft onto a taxiway at Helsinki-Vantaa Airport. On the basis of the results of the preliminary investigation it was decided that there is no need for a full safety investigation.

The most important information gathered during the preliminary investigation is recorded in this report. The original Finnish language version of the report was published on 22 July 2020.

Investigation: L2020-E1
Preliminary investigation 3/2020
ISBN: 978-951-836-576-4 (PDF)

Cover photo: Finavia

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1 EVENTS

1.1 Sequence of events

There were 15 passengers and four crewmembers on board on the scheduled flight from Tallinn to Helsinki on 30 June 2020. The flight departed Tallinn at 11:44 and landed at Helsinki-Vantaa Airport at 12:03. The aircraft was an ATR 72-212A, registration OH-ATG.

At approximately 12:04 while taxiing after the landing a crackling noise came from the electric rack panel behind the co-pilot. Soon thereafter, the pilots received ELEC SMK (electrical smoke) and MASTER WARNING warnings, and thick smoke began to billow out from between the panels into the cockpit.

The captain stopped the aircraft on the taxiway and made a call-out for the cabin crew to be ready. The flight crew began to go through the evacuation checklist. The captain declared an emergency by calling Mayday on the radio and told the Air Traffic Control that the passengers would be evacuated onto the taxiway. Once the engines had been turned off and it was safe to evacuate the passengers, the smoke stopped coming into the cockpit. The captain decided that a rapid evacuation was no longer needed so he called the senior member of the cabin crew and requested that the passengers be evacuated through the main door. The reason for this was that it is safe to do so with the small number of passengers and because there was no longer a need to use the emergency exits.

1.2 Alerting and rescue operations

The ATC received the Mayday call and the information about evacuating the passengers onto the taxiway. At the time, the ATC was in the middle of a training session. Therefore, in addition to the air traffic controller on duty, the supervising instructor air traffic controller also managed the situation. In this situation the air traffic controller on duty managed radiocommunication on the Tower and Ground frequencies, while the instructor air traffic controller was carrying out alerts. The alert was made by using a pushbutton. Instead of using the 'aircraft accident' pushbutton, the 'full emergency' pushbutton was depressed. This being the case, the alerted rescue service response was two rescue unit levels below that of an aircraft accident response.

At 12:05:47 the Emergency Response Centre (ERC) dispatched units as per response '236 B aviation full emergency – large'. In addition to the airport rescue units, this response included units from the Central Uusimaa and Helsinki rescue departments.

After having made the alert with the pushbutton, the instructing air traffic controller called the ERC to provide additional information. The first one of three phone calls was made at 12:07:34. During this call the air traffic controller explained to the ERC's duty officer that there was a full emergency at the airport. The reason for the emergency was an ATR airliner which was presently evacuating passengers onto the taxiway. The air traffic controller could not provide a precise passenger count. However, he told the duty officer that the number was less than 70. During the second call, at 12:21:50, the air traffic controller was still talking about a full emergency, or evacuation, and explained that all 15 passengers had evacuated. The cause for the evacuation was smoke in the cockpit, and Finavia's rescue service was already at the site. During the third phone call at 12:33 the air traffic controller reported that *full emergency or, more precisely, aircraft accident* conditions were no longer in force.

While enroute to the accident site, *LentoP30*, the rescue service shift supervisor, received more information from the TWR. He then ordered an airport bus to the site to transport the passengers to the terminal. The first airport rescue units arrived at the aircraft at 12:08:10.

The captain told the arriving rescue personnel that all passengers and crewmembers had deplaned, and that the reason for the evacuation was smoke in the cockpit. The rescue personnel checked the aircraft with their thermal camera for any signs of fire. However, no heat sources were detected. The passengers and the crewmembers were first sheltered from the rain inside rescue vehicles. Once the airport bus arrived, approximately 6 minutes later, the passengers boarded the bus. The crewmembers were transported by the airline's crew transport vehicle.

The first Central Uusimaa Rescue Department units arrived at checkpoint 2. At approximately 12:14:30 they were escorted by a security guard to a standby location reserved for emergency units during full emergencies. At first the escort did not know for certain where the aircraft was but *P43*, the divisional officer on duty, received confirmation regarding the position from the rescue service shift supervisor over the radio. Then the security guard escorted the rescue units to the aircraft. The rescue service shift supervisor still double-checked from the airport's central security control room that the security guard knew how to get to the site. The manoeuvring area chart/map was not used in positioning the aircraft; the map had been created as a result of a previous accident, on the recommendation[1] of the Safety Investigation Authority, to improve access for authorities and others to an accident site on the manoeuvring area.

The rescue service shift supervisor explained the situation to the rescue department's divisional officer on duty, who then called off the remaining dispatched units still enroute to the site.

The passengers were evacuated through the main cabin door onto the taxiway. As the crewmembers were in the middle of evacuation procedures, no-one told the deplaning passengers where to go at first. However, the first rescue units arrived within 50 seconds from the time the first passenger deplaned. Some passengers took along small carry-on luggage as they left the aircraft.

The aircraft was towed away from the manoeuvring area to the apron at 12:35. At the apron the passengers were allowed to collect their carry-on luggage in groups of five. The aircraft was then emptied of luggage and cargo.

1.3 Consequences

The occurrence did not result in injuries to persons nor significant interruption to Helsinki-Vantaa's operations, owing to slow traffic. The airport resumed normal operations at approximately 12:19.

The aircraft was towed for repairs, where the faulty relay was replaced and system operations were inspected. The aircraft returned to flight service the following day, on 1 July 2020.

[1] L2018-04

2 BACKGROUND INFORMATION

2.1 Environment, equipment and systems

2.1.1 Aircraft information and occurrence-related system information

The ATR 72 is a twin-engine turboprop feederliner intended for short routes. Its length is 27.2 m and wingspan 27.1 m. Its maximum passenger capacity is 76 and its range is 1685 km. The serial number of the occurrence aircraft is 757 (MSN) and it was manufactured and entered into Finland's aircraft register in 2007.

The ATR 72-212A is powered by a pair of 2.750 shp Pratt & Whitney Canada PW127 turboprop engines, which drive six-bladed Hamilton Standard propellers. Propeller anti-icing is ensured by heating elements installed on each propeller blade. The heating elements consist of electrical resistors supplied with 115 VACW. When they heat, they loosen the accumulated ice off the leading edge of the propeller blade. The heating elements are electrically supplied in cycles; when the system is on, only half of the blades are heated at a time. The heating elements are grouped by odd-numbered propellers (1-3-5) and even-numbered ones (2-4-6). Both propellers have independent electrical circuits. The electrical connection to the propellers is provided by brush blocks situated behind the propeller hubs. The brush blocks supply electrical power to slip rings attached to the rear surface of the propeller hub bulkheads; the blade heating element wiring is on the slip rings.

Both heating systems are protected against short circuit with 50A circuit breakers. Normally, the heating elements receive 42A, at maximum. When the anti-icing system is on, the current running in the heating elements is monitored by current transformers. The current transformers are connected to MFC (Multi-Function Computer) units which regulate blade heating. On the basis of the load information in the supply circuits they monitor the condition of the propeller blade heating elements and will indicate a fault in anti-icing if the current in the heating elements is not sufficiently high. This is how the system detects, among other things, failures in heating element circuits. The information provided by the current transformers is not used for any other monitoring purpose, such as overcurrent or switchoff monitoring.

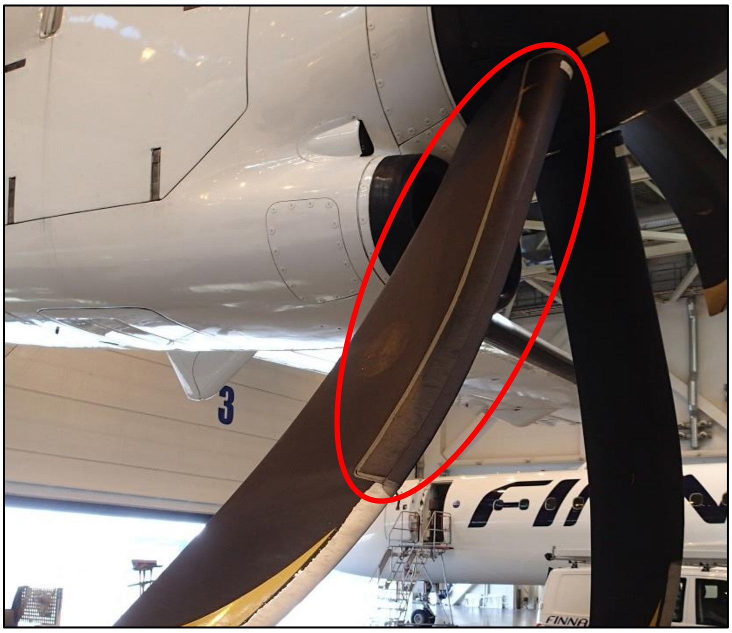

Figure 1. ATR72-212A propeller blade, the anti-icing heating element is circled in the photo. (Photo: SIA)

The MFCs control the blades' heating element cycles, following two operating modes to odd-numbered and even-numbered propellers through two independent relays. The relays are positioned on the right side of the cockpit in the avionics bay behind the pilots. The current transformers that monitor the load in the heating circuits are also in the same bay. The aircraft's fire warning system monitors ventilation in the equipment bay. When it detects smoke, it displays an ELEC SMK warning which, in turn, generates the MASTER WARNING.

The heating elements' cycling control relays are Zodiac Aerospace 101CC01A2 propeller control relays. Their main moving contact (1-2) is limited to 75A, in the temperature range of -55°C - +125°C. The nominal voltage of the control coil (3-4) is 32VDC.

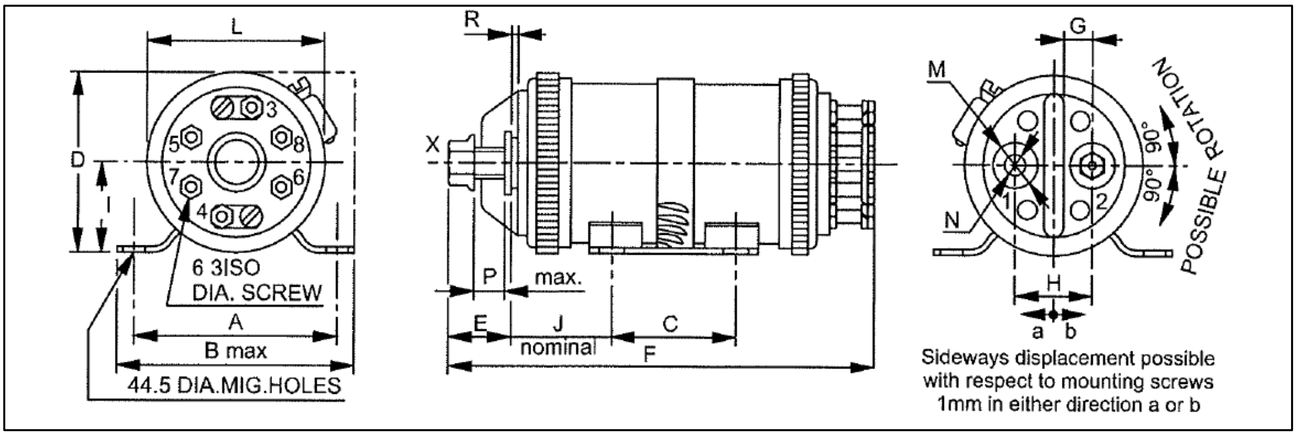

Figure 2. Zodiac Aerospace 101CC01A2 relay diagram. (Image: Zodiac Aerospace)

The propeller control relay's operation is based on a longitudinally moving spring-loaded trunnion. The spring keeps the trunnion at rest, which is when the main moving contact's swivelling insulating plate, attached to the bottom of the trunnion, remains in the open position. When the relay's coil receives control voltage it magnetises. Then the trunnion and the swivelling insulating plate move against the fixed contacts and the contact between 1-2 closes. The swivelling insulating plate and the trunnion are cylindrical. In order to prevent twisting, the plate is fitted with a centring pin which fits into an aligning hole at the end of the relay.

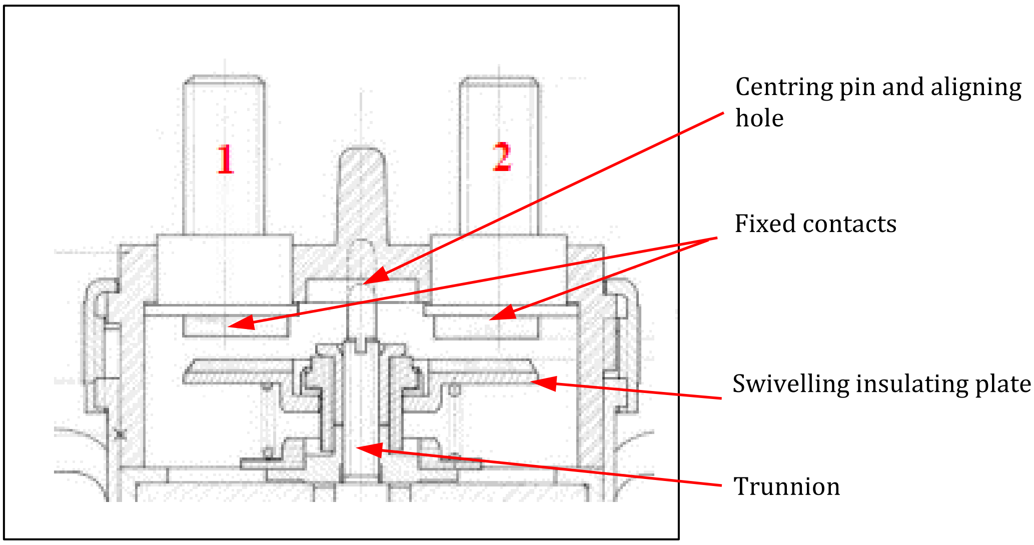

Figure 3. Cross-section of Zodiac Aerospace 101CC01A2 relay in the open position.

Propeller anti-icing was used on the occurrence flight. Anti-icing was turned on three minutes after take-off at 11:47. The system was turned off nine minutes before landing, at 11:54. While the aircraft was taxiing after landing, the MASTER WARNING activated at 12:04.

In the inspections conducted by the aircraft's maintenance organisation the propeller 1-3-5 anti-icing relay, position 18DH, proved to be the cause of the smoke. Its main moving contacts and the end of the relay had melted. The relay had experienced a fault 10 minutes after the anti-icing system was turned off. The fault caused the relay's contacts to overheat, which in turn damaged and partly melted the propeller control relay inside the avionics bay. There was abundant dust around the relay and wiring inside the avionics bay. Traces of burnt dust were also detected in the compartment above the burnt avionics bay.

The avionics bay is normally vacuumed and cleaned of dust and grime during more extensive periodic maintenance. Judging by the large amount of dust the cleaning had possibly been omitted, or poorly done, during the previous maintenance.

Figure 4. The burnt anti-icing system relay, the photo was taken before repairs. (Photo: Norra)

The serial number of the failed propeller control relay was 23374, and it was manufactured in February 2007. This being the case, the relay had been in this aircraft since its manufacture. It is not a life limited part, nor does it have a designated service life. However, in the component maintenance manual (CMM) the manufacturer provides instructions for testing the relay.

The preliminary investigation did not establish the cause of the failed relay. Its control wiring was intact and attached to the unit. The electrical wiring to the propellers had melted off of the relay. The contacts with which the wires are connected to the relay were still attached to the ends of the wires. The insulations in the propeller control relay had completely burnt on the side of the propeller electricity supply. The relay was partly disassembled but no clear indication of the cause of the fault was found inside it. The contact surfaces and the swivelling insulating plate had melted completely.

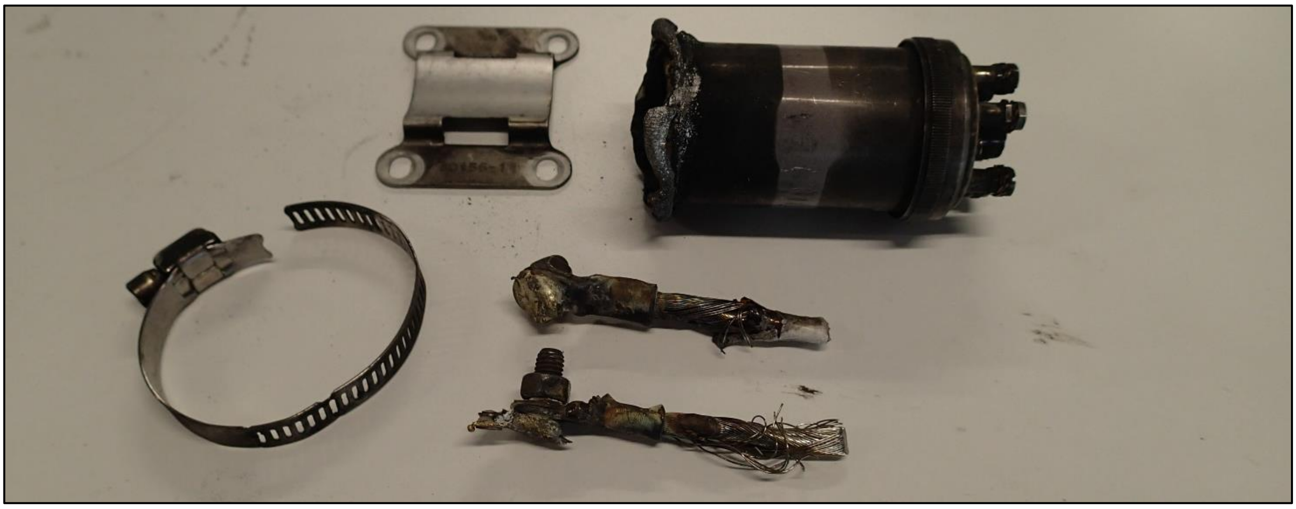

Figure 5. Parts of the relay. The end of the main moving contact had melted and contact surfaces 1 and 2 had loosened from the end. The main moving contact had completely melted. (Photo: SIA)

The end of the relay's control voltage and of the auxiliary contacts were intact. Similarly, the coil was intact and the trunnion moved freely inside it. Also, the spring which keeps the trunnion in its default (rest) position was intact.

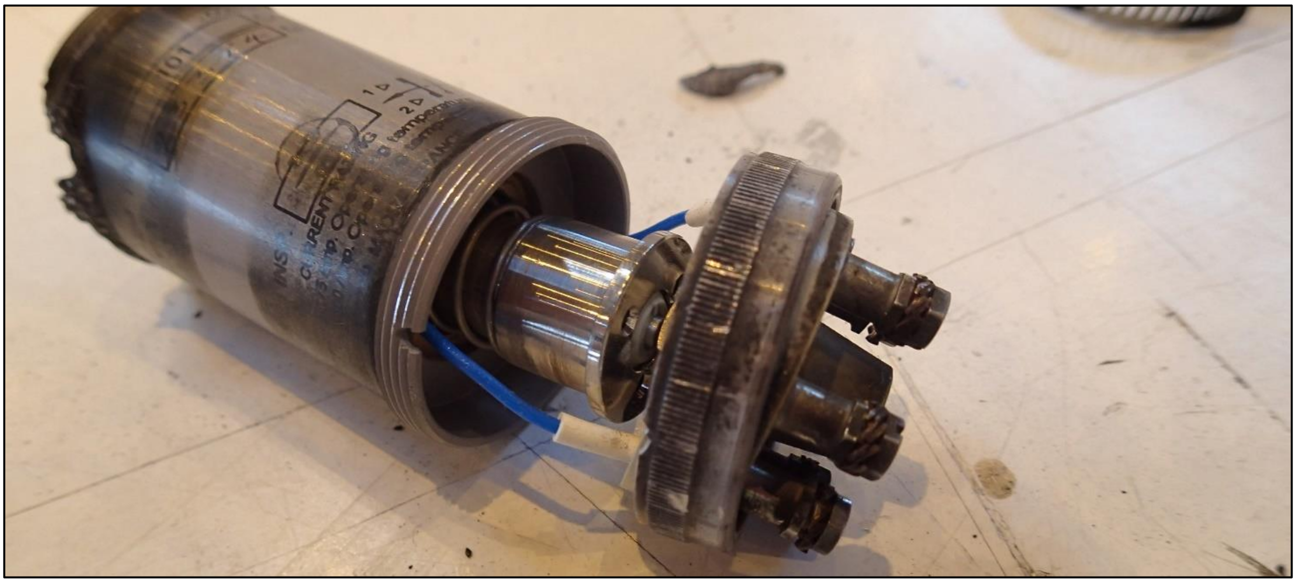

Figure 6. The opened end of the relay's control voltage and auxiliary contacts. The trunnion and its spring are visible inside the relay. The blue wires connect contact points 3 and 4 to the coil. (Photo: SIA)

Excluding the propeller control relay, the propeller anti-icing system was deemed to be fully functioning, and after the relay was replaced the system has performed normally.

The 50A circuit breaker in the anti-icing system worked in this situation as designed. It operates on the basis of the heating effect of the current that travels through it and is designed to detect overcurrent in the circuit. If the current exceeds the component's tripping value, it overheats and interrupts the circuit. This kind of situation may arise, for example, when there is a short circuit in the heating system. If the relay fails internally in such a manner that the contact remains partly or completely closed, the current will not exceed the 42A maximum current received by the anti-icing system's resistors. Then the circuit breaker will not trip.

2.1.2 Air Traffic Control information

The ATC was in the middle of a training session. The air traffic controller on duty was supported by another, supervising instructor, air traffic controller. In this situation the duty air traffic controller's required ratings were also valid for operating independently; the training event was essentially recurrent training following a lengthy break. The training did not have any impact on the ATC's performance during the accident.

From the viewpoint of the ATC traffic was slow. At the time of the occurrence two aircraft were approaching runway 04R, the first one being the incident aircraft. When the runway was free the second aircraft received its landing clearance. It vacated the runway via another taxiway, from in front of the aircraft that had stopped for evacuating. At that time no-one had yet deplaned the evacuation aircraft.

2.2 Conditions

Weather at Helsinki-Vantaa Airport on 30 June 2020 at 12:00: Cloudy and rain. Temperature 13.1°C. Winds were west-southwesterly, 256° at 6 m/s, gusting to 8.2 m/s. Rain intensity was 2 mm/h. Visibility was 12730 m.

2.3 Recordings

The investigation had access to the aircraft's flight data recordings (QRA), the ATC's radiocommunication and ground traffic recordings, the rescue service's and the ERC's telephone recordings as well as the video recordings of an airport rescue service vehicle. The most important information of these recordings is presented in subchapters 1.1 Sequence of events and 1.2 Alerting and rescue operations.

The aircraft's flight data recorder information was used to establish the history of the flight, the use of the propeller anti-icing system and the time of the electrical smoke warning.

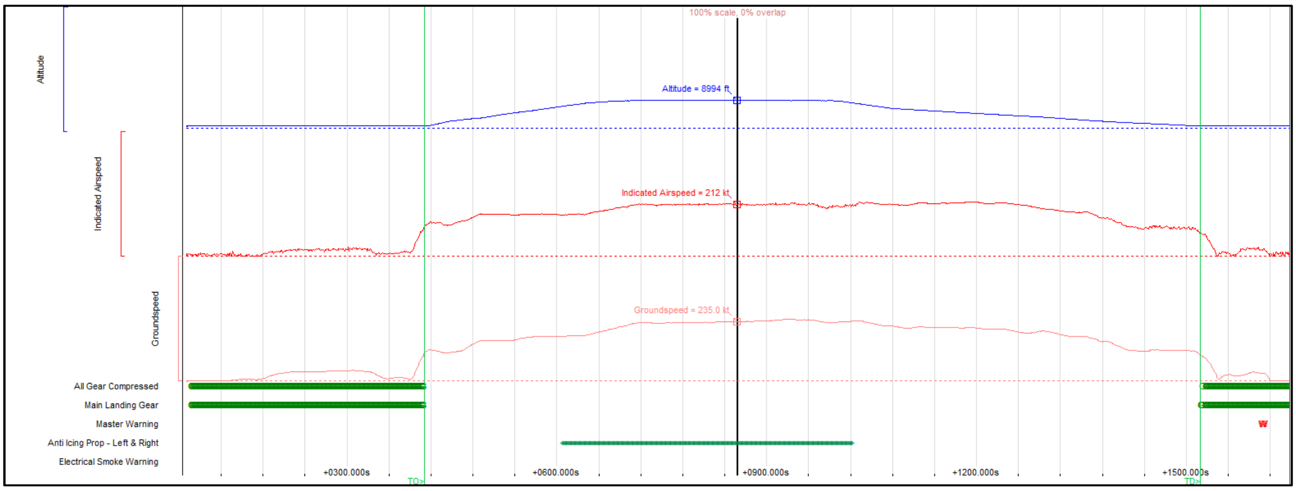

Figure 7. A graph compiled from the OH-ATG's flight data recorder information. (Image: Norra)

2.4 Personnel, organisation and safety management information

Nordic Regional Airlines (Norra) is an airline which operates a sizeable part of Finnair's domestic and European scheduled traffic. Norra's fleet comprises of 24 aircraft, 12 of which are ATR72s. The operator, the air operator licence holder, is responsible for the airworthiness of its aircraft, and maintains them in accordance with the approved maintenance programme.

Aircraft maintenance, repairs and modifications must be carried out in a licenced maintenance organisation approved by the aviation authority. Norra has valid maintenance contracts with Finnair concerning line maintenance and with the Slovenian Solinair with regard to more extensive periodic maintenance.

The aircrew consisted of the captain, the co-pilot and two cabin crew. Their licences, ratings and certifications were valid and their recurrent training, evacuation exercises included, had been appropriately completed.

Occurrence reporting was appropriately made, in accordance with the Regulation (EU) No 376/2014 of the European Parliament and of the Council on the reporting, analysis and follow-up of occurrences in civil aviation.

2.5 Participating rescue services and their preparedness

Kerava Emergency Response Centre is part of the Emergency Response Centre Administration. The task of the ERC is to receive emergency calls, make risk assessments and dispatch units in accordance with each competent authority's alerting instructions.

Finavia maintains Helsinki-Vantaa Airport. The airport runs its own 24/7 rescue service for accidents and standby situations at the aerodrome area, as per aviation regulations. Helsinki-Vantaa is responsible for the rescue actions and preparednesses which, pursuant to the Rescue Act, are not the responsibility of regional rescue services. The rescue service shift supervisor commands rescue actions at the airport until the regional rescue department has been informed of the occurrence.

Central Uusimaa Rescue Department is responsible for rescue operations inside the aerodrome area. Under the Rescue Act the local rescue service region is in charge of rescue operations when an accident happens at or near the aerodrome.

2.6 Rules, regulations, procedures and other documentation

Commission Regulation (EU) No 748/2012 on rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations, lays down standards and requirements for the reliability and safety of aircraft systems and their equipment. In the type-certification phase the propeller control relay in question was regarded as a component which has no designated life limit and maintenance requirements.

Commission Regulation (EU) No 1321/2014 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks defines how, when, by whom and on whose responsibility the maintenance and monitoring of an aircraft's airworthiness is done during flight operations. The operator, the airline, must among other things maintain and analyse the technical reliability programme and, when necessary, amend the approved maintenance programme. The holder of type-certification, the aircraft manufacturer, also collects such material and recommends improvements to increase the dependability and service reliability of systems, parts and components.

2.7 Other investigations

Norra's similar ATR 72-500 turbo-prop airliner on Finnair's scheduled flight was evacuated on 30 January 2019 at Tallinn Airport soon after landing. The reason for the evacuation was smoke generation in the cockpit. The occurrence is being investigated by the Estonian Safety Investigation Bureau OJK[2]. The OJK has assisted the Safety Investigation Authority's investigation regarding the occurrence at Helsinki-Vantaa on 30 June 2020.

[2] Ohutusjuurdluse Keskus

3 CONCLUSIONS

The conclusions include the causes of the accident or incident. Cause means the various underlying factors of the occurrence and the direct and indirect factors affecting it.

1. The passengers were rapidly, and in a controlled manner, evacuated through one door

   Conclusion: *The evacuation was made easier by the small number of passengers and the fact that most carry-on luggage was left behind.*

2. The alert was made as “full emergency”, even though in this instance the correct response should have been “aircraft accident”. The alerts are made using automatic pushbuttons at the ATC.

   Conclusion: *Sufficient rescue equipment and personnel in accordance with contingency planning are critical for effective rescue and firefighting operations.*

3. Smoke generation inside the cockpit is always problematic. The relay is positioned inside a metallic avionics bay, which reduces the risk of a fire spreading outside it. During the flight the bay vents into open air.

   Conclusion: *The manufacturer can reduce the consequences of risk-prone part failures by positioning them appropriately in the aircraft.*

4. The damaged relay is not a life limited part, nor does it have a designated service life.

   Conclusion: *The relay will be used more frequently in Nordic conditions compared to the south. Therefore, the relay will probably wear out sooner.*

5. The smoke detected by the pilots and aircraft systems came from the faulty relay. Burning dust inside the avionics bay increased the smoke generation.

   Conclusion: *Avionics bays are only opened during more extensive periodic maintenance, or when systems fail. Dust accumulation is not monitored. Excessive dust and grime speed up equipment overheating because of degraded cooling and strengthen a developing fire.*

6. The propeller heating circuits are protected against short circuit by 50A circuit breakers.

   Conclusions: *The fault and the consequent relay damage did not generate sufficient resistance to trip the circuit breaker. However, they did generate enough heat to start a fire inside the avionics bay. When the contact surfaces melt together the aircraft system continues to provide current to the propeller in an uncontrollable manner. If the fault continues for an extended period, it will likely damage the anti-icing system.*

4 SAFETY RECOMMENDATIONS

The preliminary investigation does not issue any new recommendations.

4.1 Suggestions for improvement

The operator should, together with the aircraft manufacturer, add the type 101CC01A2 relay to the periodic inspection list and, possibly, consider it a HT time-monitored[3] component.

At the same time, it is suggested that the inspection period for cleaning the avionics bay be shortened to prevent possible dust accumulation.

4.2 Implemented measures

The aircraft operator has implemented proactive action so as to prevent any similar occurrences. All of the company's ATR propeller anti-icing system relays will be measured and tested as per the manufacturer's instructions. Should any relay fail to meet the manufacturer's limits, it will be replaced. At the same time the avionics bays in which the relays reside will be vacuumed and cleaned.

[3] Hard time (HT) components require specific action at specific intervals (e.g. overhauls and testing) as per the manufacturer's recommendations. The period can involve calendar time, flight hours or the number of landings.