



Investigation report

C8/2008L

Airliner fire at Kemi-Tornio aerodrome on 11 December, 2008

Translation of the original Finnish report

OH-EBE

EMB-145LU

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SUMMARY

A serious incident occurred at Kemi-Tornio aerodrome on 11 December 2008 at 22:53 UTC when a Finnish Commuter Airlines passenger aircraft caught fire after landing. Accident Investigation Board Finland appointed investigation commission C8/2008L to this occurrence. Investigator Markus Bergman was named investigator-in-charge, accompanied by investigator Tapani Vanttinen as a member of the commission. Sanna Winberg, Supervisor, Safety and Cabin Service Training, was named cabin safety expert to the commission. Investigator Pekka Orava was invited as an air traffic control advisor to the commission.

After landing the auxiliary power unit (APU) start failed and simultaneously a major power failure occurred. While the passengers were still onboard the loadmaster, a member of the ground crew, detected a fire in the back of the aircraft. The aircraft's own fire suppression system was successfully used to extinguish the fire. While the incident did not cause any injuries to persons, the aircraft suffered minor damage.

The investigation revealed shortcomings in pilot action as well as in the APU's fire detection system and company regulations.

The incident occurred when a fire broke out in the APU while the aircraft was taxiing to stand after landing. Flames reached the APU tailpipe as well as the APU compartment. At first the pilots did not notice the fire because the aircraft's warning system did not signal a fire alarm. The ground crew alerted the pilots of the fire. When the fire started, the passengers were still onboard and deplaned while the fire was burning. Several simultaneous faults affecting the aircraft's operation exacerbated the severity of the incident. The pilots were occupied with the APU generator's failure to couple, the unexpected activation of the overcurrent protection feature as well as the failed APU start, which took their attention and slowed their response to the fire. The power failure also made the cabin attendant's work more difficult, slowing down passenger exit as normal cabin lighting was off. The air traffic control did not notice the fire, nor was it informed of the occurrence. No alert was given, nor did the emergency unit on location react to the situation during the fire.

The investigation commission issued four safety recommendations. The manufacturer of the aircraft is advised to ensure that the APU's fire alarm system always signals a reliable warning in different kinds of fire situations. The airline is advised to ensure that the manufacturer's AOM revisions are included in its OM-B. The airline is advised to ensure that the pilots record all appropriate information in the technical logbook with regard to faults, incidents and observations that may impact flight safety or an aircraft's airworthiness. Finally, the airline is advised to guarantee their aircrews' Multi-Crew Coordination competence as well as their capability to operate in accordance with the company manuals.

The draft final report was sent for comments to CAA Finland, the Center for Investigation and Prevention of Aeronautical Accidents of Brazil, the European Aviation Safety Agency as well as to the aircraft manufacturer and operator. The comments were taken into account in the final investigation report, as applicable. The aircraft manufacturer's and operator's comments are appended to this investigation report.

The investigation was completed on 2.2.2010.



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ABBREVIATIONS

AMM	Aircraft Maintenance Manual
ANAC	Agência Nacional De Aviação Civil National Civil Aviation Agency – Brazil
AOM	Aeroplane Operating Manual
APU	Auxiliary Power Unit
ATPL	Airline Transport Pilot License
ATS	Air Traffic Service
°C	Degrees Celsius
CAM	Cabin Attendant Manual
CB	Circuit Breaker
CENIPA	Centro de Investigação e Prevenção de Acidentes Aeronáuticos Center for Investigation and Prevention of Aeronautical Accidents of Brazil
CMC	Central Maintenance Computer
CPL	Commercial Pilot License
CVR	Cockpit Voice Recorder
EAP	Emergency/Abnormal Procedures
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Control
FCL	Flight Crew Licensing
FDR	Flight Data Recorder
FT	Feet, dimensional unit
GCU	Generator Control Unit
GEN	General, Generator
ICAO	International Civil Aviation Organization
JAR	Joint Aviation Requirements
MCC	Multi-Crew Coordination
MEL	Minimum Equipment List
MFD	Multifunction Display
NTSB	National Transportation Safety Board
OM-A	Operations Manual Part A
OM-B	Operations Manual Part B
OR	Occurrence Report
PHI	Safety report
QNH	Altimeter Setting, mean sea level pressure
QRH	Quick Reference Handbook
SMS	Safety Management System
SOP	Standard Operating Procedures
SRM	Structural Repair Manual
TSO	Technical Standard Order
UTC	Co-ordinated Universal Time
VHF	Very High Frequency

SYNOPSIS

A serious incident occurred at Kemi-Tornio aerodrome on 11 December 2008 at 22:53 UTC (00:53 Finnish time) on Finnish Commuter Airlines scheduled flight FCM379N from Helsinki to Kemi. The aircraft, registration OH-EBE, was an EMB-145LU turbojet airliner manufactured by Empresa Brasileira de Aeronáutica S.A. After landing in Kemi the APU start failed, resulting in a fire. Moreover, the aircraft suffered a major power failure. The incident did not cause any injuries to persons but did result in minor damage to the aircraft.

Accident Investigation Board Finland appointed investigation commission C8/2008L to this occurrence. Investigator Markus Bergman was named investigator-in-charge, accompanied by investigator Tapani Väänttinen as member of the commission and Sanna Winberg as cabin safety expert. Investigator Pekka Orava was the air traffic control advisor. Pursuant to ICAO Annex 13, AIB Finland notified ICAO, the Brazilian accident investigation authority CENIPA as well as the aircraft manufacturer Embraer and the U.S. accident investigation authority NTSB of the incident.

All times in this report are in UTC. The investigation report was translated into English. The material used in the investigation is stored at the Accident Investigation Board Finland.

1 FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Crew actions

The pilots' shift began at 13:15 in Helsinki. During the course of the day they had flown twice to Kemi and back and were on their way to Kemi for the third time. The flight landed on runway 36 at Kemi-Tornio aerodrome at 22:52. After the landing roll they turned left onto taxiway A and continued on it to the apron. In accordance with standard operating procedures (SOP) the captain taxied the aircraft and the co-pilot went through the checklist.

Both engines were running and the two generators on each engine were producing the required electrical power. During taxiing the auxiliary power unit (APU) was started; it normally generates power for aircraft systems after the main engines are shut down. This time, however, the APU generator did not couple to the aircraft's electrical system. The pilots reset the generator during taxiing so as to bring it online. This too failed. They then decided to turn the APU off and restart it in order to get the generator to connect. As the aircraft was approaching its stand the left engine was shut down simultaneously with the second attempt to start the APU. These two actions together caused an overcurrent situation in the electrical system, triggering the activation of the overcurrent protection feature and locking a number of electrical relays open. As a result, some of the buses normally fed by the left engines' generators were left without power.

The aircraft was stopped at stand one; parallel with the aerodrome terminal but pointing to the South. It took 1 minute 45 seconds for the aircraft to reach the stand after landing. Approximately 50 seconds after the left engine was shut down the right engine was also shut down. As a result of this the aircraft lost almost all electrical power. With regard to the flight deck the only systems that still had power were the emergency lights, standby instruments, the Engine Indication and Crew Alerting System (EICAS) and the other VHF COM radio.

As a result of the power failure normal cabin lighting turned off. When the fasten seat belt lights turned off the passengers got up and began to collect their belongings from the overhead storage. The cabin attendant asked the pilots what had happened and they informed her of the power failure and allowed her to open the front cabin door. The cabin attendant advised the passengers to deplane carefully. It is not known whether the cabin emergency lighting was on or whether the apron lights were sufficiently bright for the passengers to collect their belongings and exit the aircraft. Cabin Attendant Manual (CAM) 3.12 instructs the cabin crew to use flashlights if normal lights turn off. However, the cabin attendant said that there was no need for this because it was bright enough for the passengers to safely exit the aircraft.

When the cabin door was opened the loadmaster, a member of the ground crew, came to the cockpit to inform the flight crew that he had detected fire and smoke in the back of the airplane. Even before the door opened he had tried to notify the pilots of the fire via hand signals. The captain exited the aircraft among the passengers and saw smoke at the back of the plane. As the last passengers were deplaning, he discharged the APU fire extinguisher bottle. The pilots had not informed the passengers of the occurrence nor was the cabin attendant aware of the fire at this point in time. The pilots had not reported the fire to the air traffic control either.

After the passengers had left the aircrew remained onboard. The cabin attendant waited for the pilots in the cabin. When the smoke was gone the pilots gave their full attention to the electrical problems. They tried to turn all power off, but failed. They discussed the situation with each other, made some phone calls and conversed with the ground crew. Only when they disconnected the battery leads did they manage to turn all of the power off.

The captain remained onboard after the rest of the crew left the aircraft. The cabin attendant asked the co-pilot what had happened but received only scant information in return. The cabin attendant thought that she was not more fully informed about the situation at the time because the pilots, too, were unsure of the situation.

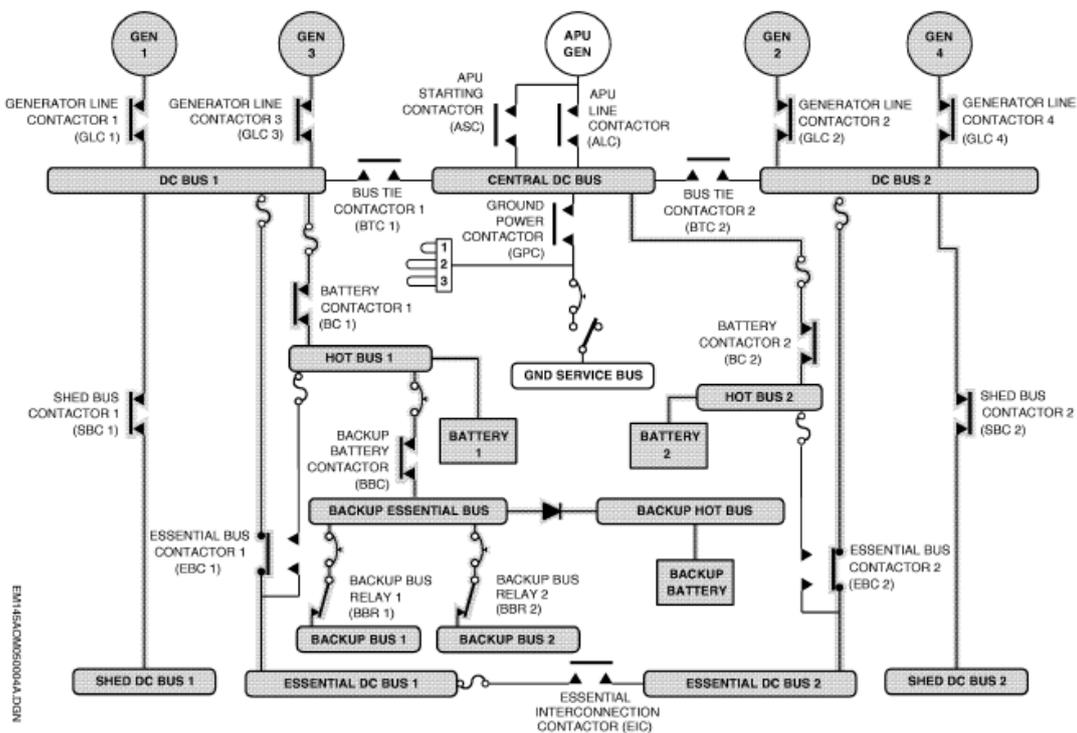


Figure 1. Electrical system: normal state when the APU is not on (E-145 OM-B)

1.1.2 APU start

During the first APU start the pilots, according to their statement, received an APU caution on the EICAS. They said that they double-checked on the system page that the APU generator was not coupled to the aircraft's electrical system. After the failed reset attempt they decided to turn the APU off and on again in order to bring the generator online.

According to the pilots, they initiated the APU restart sequence while it was still spooling down from shutoff. The left engine was simultaneously shut down. This is when an overcurrent situation occurred, leaving some buses without electrical power and triggering several EICAS warnings and cautions. The APU did not start on the second attempt.

The right engine was shut down approximately 50 seconds after left engine shutdown. This resulted in the loss of almost all electrical power and again triggered several warnings and cautions.

When the ground crew loadmaster came to the flight deck to report a fire in the back of the aircraft, the captain went out to inspect the situation. After returning to the cockpit he discharged the APU fire extinguisher bottle which put out the fire. Activation of the fire extinguisher bottle also turns off fuel feed to the APU. At no time did the EICAS signal an APU FIRE warning.

The OM-B of the E-145 gives the limitations of the APU starter motor. The needed cool down time for the starter motor is one minute between the first three consecutive start sequences. After the third start attempt there must be a pause of 30 minutes before making any further attempts. The highest permissible tailwind component during an APU start is 30 KT (OM-B 1.3.4.1). Wind at the time was 5 KT. There is an instruction at OM-B 2.1.20.1 (Single engine taxi-in): Company recommendation is to allow 1 minute time between APU start sequence and engine shutdown.

1.1.3 Post-flight action

The pilots called the company's technical personnel in Helsinki and informed them of the situation and requested technical assistance for the morning in Kemi. The pilots also informed the company's operations control that the morning flight had to be cancelled due to technical reasons. The captain called the company's flight operations manager the following morning and discussed the situation as well as the need to save the Flight Data Recorder and Cockpit Voice Recorder data. Based on the information given by the captain, it was mutually decided that there was no need to save the data.

Finnish Aircraft Maintenance (FAM) mechanics flew from Helsinki to Kemi on the first flight the morning following the occurrence. FAM provides aircraft maintenance services to Finnish Commuter Airlines. The mechanics began analyzing the electrical problem and received additional repair instructions from Helsinki. The electrical system was inspected and reset and, with regard to this system, the aircraft was pronounced airworthy. The mechanics made a visual inspection of the APU including its immediate

surroundings. Since the APU fire extinguisher bottle had been discharged, the APU was deactivated in accordance with the manner prescribed in the aircraft's Minimum Equipment List (MEL). It was decided that the aircraft was airworthy with regard to this as well. The appropriate information was signed into the aircraft's technical logbook and the aircraft was ferried back to Helsinki later that day.

After the ferry flight the pilots submitted a written Occurrence Report (OR) to the company and the authorities. The cause of the occurrence was given as *Technical incident*. In the OR's appendix the captain estimated that the incident did not directly endanger the passengers or the crew. The cabin attendant did not file a cabin safety report of the occurrence. Finnish Civil Aviation Authority informed AIB Finland of the incident on Monday, 15 December 2008. AIB investigators made a preliminary investigation of the aircraft including its documents on 15 December 2008.

After the ferry flight the following inspections were made as per regulations: SRM, Structural Repair Manual, and AMM, Aircraft Maintenance Manual: Task 05-50-11, APU fire warning inspection/check. The inspections revealed heat induced paint blistering on the external surface of the APU's cowling panel and discoloration on the inside of the same panel. The aircraft was grounded until the manufacturer commented on the aircraft's airworthiness. The aircraft manufacturer instructed the company on the required measures and gave permission to continue operations until the next inspection A, i.e. approximately 400 hours. The aircraft returned to service with its APU deactivated.

1.2 Injuries to persons

There were no injuries to persons.

1.3 Damage to aircraft

The fire caused visible damage to the structure of the APU compartment and the APU's electrical wiring. The APU was later replaced and the damaged APU was sent to REVIMA APU in France for inspection and repair. Faults and wear were detected but there were no fuel leaks, for example.



Figure 2. The external surface of the APU's cowling.



Figure 3. The Exhaust Gas Temperature (EGT) sensor's electrical wiring and the fire detector sensing element.

1.4 Other damage

There was no other damage.

1.5 Personnel information

Pilot-in-command: Age 44.

Licences: Air Transport Pilot's Licence (JAR-FCL ATPL), valid until 10.10.2013.

Medical certificate: JAR class 1, valid until 5.3.2009.

Ratings: All required ratings were valid.

Flying experience	Last 24 hours	Last 30 days	Last 90 days	Total
All types	5h 55 min	47h 50 min	213 h 20 min	ca. 7500 h
Type in question	5h 55 min	47h 50 min	213 h 20 min	ca. 3000 h

Co-pilot: Age 54

Licences: Commercial Pilot's Licence (national CPL), valid until 23.10.2010.

Medical certificate: Class 1, valid until 15.4.2009.

Ratings: All required ratings were valid.

Flying experience	Last 24 hours	Last 30 days	Last 90 days	Total
All types	5h 55 min	78 h 50 min	208 h 10 min	ca. 8500 h
Type in question	5h 55 min	78 h 50 min	208 h 10 min	ca. 2600 h

1.6 Aircraft information

According to the Finnish aircraft register OH-EBE was a Finnish-registered 48 seat EMB-145LU twin-turbojet airliner, manufactured in 2000. The aircraft was manufactured by Empresa Brasileira de Aeronáutica S.A., owned by Celestial Aviation Trading 24 Limited and operated by Finnish Commuter Airlines. The airworthiness certificate was valid until 31.1.2009.

1.7 Meteorological information

Night conditions prevailed at Kemi-Tornio aerodrome at the time of the occurrence. Wind was 080 deg five KT, visibility over 10 km, overcast at 1500 FT, temperature -8°C and QNH 1030 hPa. Meteorological conditions had no effect on the occurrence.

1.8 Aids to navigation and radars

Not relevant to the investigation.

1.9 Communications

Radiotelephony and telephone communications operated normally. The VHF COM-1 radio gets its power from a bus which, as per the DFDR, was powered up throughout the incident. Therefore, VHF-1 would have been available in spite of the electric faults. No alerts related to the incident were made, nor was the occurrence discussed over the radio or telephone. The aircrew and the ATC communicated on the TWR VHF frequency. All recorded radio and telephone conversations were made available to the investigation commission.

1.10 Aerodrome information

The incident occurred at Kemi-Tornio international airport, located at 65°46'45"N, 024°35'05"E. Aerodrome elevation is 61 FT MSL. There is one runway 18/36 which is 2503 metres long and 48 metres wide. Finavia is the operator of the aerodrome as well as its Air Navigation Service provider.

RTG Ground Handling takes care of Finnish Commuter Airlines' ground handling services at Kemi-Tornio.

1.11 Flight recorders

Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) information as well as APU Full Authority Digital Engine Control (FADEC) and Central Maintenance Computer (CMC) data were downloaded from the aircraft. Neither the FDR nor the CVR were stopped immediately after the occurrence. Instead, they were stopped and removed from the aircraft after the ferry flight to Helsinki the following day. It seems that both recorders had been operating normally. However, due to the delay CVR information, valuable to the investigation, was lost. FDR, CMC and FADEC data provided useful information. Finnish Aircraft Maintenance delivered APU FADEC and CMC recordings to the investigators. Finnish Commuter Airlines OM-A (8.3 and 11) requires that flight recorder data be saved after accidents, serious incidents or at the behest of an authority.

1.12 Wreckage and impact information

Not relevant to the investigation.

1.13 Medical and toxicological information

No medical or toxicological tests were conducted.

1.14 Fire

When the aircraft was taxiing to the apron a fire broke out in the APU. Two eyewitnesses detected the smoke even before the aircraft came to a halt at the stand. It is not known for certain how long the fire lasted but can be estimated on the basis of the following chain of events: The fire started during taxiing and continued until the aircraft came to a halt, both engines were shut down, the cabin door was opened, the loadmaster reported the fire to the pilots, the captain went out and, after detecting the fire by standing in front of the left wing, returned to the cockpit to discharge the fire extinguisher bottle. On the basis of recorded data and the investigators' estimates it can be noted that the fire burned for at least a minute and a half. When the fire started all passengers were onboard. Most of them deplaned while the fire was still burning. In spite of the fact that the APU's fire warning and extinguishing system remained operative throughout the course of the fire, it did not signal an APU FIRE alarm.

During the fire some of the flames pushed through the APU tailpipe while others entered the APU compartment. According to eyewitnesses the length of the flames and the volume of smoke visible from the tailpipe varied considerably during the fire. As a result of the fire a rivet on the inside of the APU cowling partially melted. The melting point of an aluminium rivet is approximately 660°C. The paint on the outside of the APU cowling was blistered and the colour had partially turned dark brown. This indicates that the temperature had exceeded 200°C.

1.15 Rescue operations and survival aspects

The aircrew did not inform the ATC of the incident. No rescue operation was initiated, nor was the Rescue Coordination Centre informed of the occurrence. The rescue units at the aerodrome did not respond to the fire. The pilots did not consider an evacuation necessary. Neither the cabin attendant nor the passengers were informed of the fire.

1.16 Tests and research

The APU's fire detection system was inspected and fully tested during the investigation. The APU's fire detector sensing element was sent to its manufacturer in the United States for testing. A representative of the U.S. accident investigation authority NTSB supervised the tests and delivered the results to the investigation commission.

Apart from one specification the APU's fire detector sensing element passed all tests. Although it passed all of the authorities' minimum requirements (FAA TSO-C11e), the *Low Discrete Test* (470°C at a length of 12 inches, i.e. approximately 30.5 cm) included in the sensing element manufacturer's testing regime, did not result in fire detection. The 12 inch long piece of element that was tested came approximately 50 cm from the end of the sensing element. A repeated test at the same point but at a higher temperature (498°C) also failed to pass. In addition, the same test was done at approximately 114 cm distance from the end of the element and this time fire detection worked as it was designed to.

The investigation commission requested that further testing be done on the APU's fire detector sensing element so as to ensure that the point of the element that was most likely exposed to the flames could have triggered a fire alarm, had the exposure been sufficient. Further tests did not detect any more shortcomings in the functioning of the fire detector sensing element.

1.17 Organisational and management information

The aircraft manufacturer was aware of a possible activation of the overcurrent protection feature in conjunction with engine shutdown. They had sent Operational Bulletin 145-004/06; *Electrical loads loss associated with engines shut down* to E-145 operators in 2006. The bulletin says that the required revisions and amendments would be included in the Aircraft Operating Manual (AOM) in the fullness of time. The revisions were made in AOM revision #34, published on 30.11.2007. Finnish Commuter Airlines had included a related recommendation in the AOM 2008 (OM-B Revision 8, 16.7.2008, 2.1.20.1, Single engine taxi-in). The operator had also distributed the aircraft manufacturer's bulletin to its E-145 pilots and the subject matter was also discussed at a pilot training convention. Even though the AOM revision included essential instructions for pilots, the operator had not included all of the changes in its E-145 OM-B.

1.18 Other information

1.18.1 Incident reporting

The pilots did not report the incident to air traffic control. After the incident the same evening, the pilots reported the occurrence to company maintenance and Operations Control by telephone. The captain discussed the occurrence with the company's flight operations manager by telephone the following morning. An official Occurrence Report (OR) was submitted to the airline and the authorities on 12.12.2008 after the ferry flight to Helsinki. The OR only reached CAA Finland, from where it was relayed to AIB Finland, on 15.12.2008. The cabin attendant did not file a cabin safety report.

The air traffic controller neither noticed nor was informed of the incident and, therefore, the controller did not file a report as per Finavia's safety reporting (PHI) regulations. Neither did the rescue and maintenance personnel, on location at the time, file a PHI safety report even though they detected the fire. There was no mention of the fire in maintenance or ATC logs.

Two RTG ground handlers detected the fire and one of them went to the cockpit to report the fire. The ground handling crew did not file any written report. According to them they had no instructions regarding flight safety reports or occurrences that require reporting.

1.18.2 Ground crew action

On the day of the incident Kemi-Tornio aerodrome was scheduled to close at 23:00. FCM379N landed at 22:52. After the aircraft had taxied to apron the air traffic controller began to close the ATC. The air traffic controller did not notice anything out of the ordinary as the aircraft was arriving. Neither the pilots nor the rescue personnel reported the incident to the ATC. According to the air traffic controller's manual, the Tower provides Alerting Services.

The air traffic controller on duty at the time of the occurrence only learned of the APU fire after AIB Finland launched its incident investigation. Maintenance personnel had told the airport director that FCM379N had some trouble with its APU. Nonetheless, he, too, was officially informed of the fire only after the incident investigation began.

At first the loadmaster tried to notify the pilots of the APU fire via official hand signals outside the aircraft. However, the pilots evidently did not notice this. When the cabin door was opened the loadmaster went to the flight deck before the passengers exited the aircraft and reported the fire to the pilots. The captain went outside to check the situation and then he returned to the cockpit and discharged the APU fire extinguisher bottle. The ground handlers said that they waited at a safe distance for the smoke to clear and asked the pilots for permission to unload the baggage.

No emergency alert was made of the occurrence. However, the rescue crew on fire duty said that they had detected a fire at the back of the aircraft. The rescue crew only came to the aircraft with a command and control vehicle when the fire was already out and the passengers had deplaned. The firefighters did not discuss the occurrence with the pilots. Nobody inspected the APU before baggage was unloaded from the aircraft.



2 ANALYSIS

2.1 Post-landing events and aircrew action

The time and distance required for taxiing after landing was quite short. According to flight recorder data it took 1 minute 45 seconds for the aircraft to come to a stop. This provides enough, albeit relatively little, time for the completion of procedures as per the Standard Operating Procedures (SOP).

The latest revision of the E-145 OM-B (Revision 8 16.7.2008, 2.1.20.1, Single engine taxi-in) contains the following verbiage: *Company recommendation is to allow 1 minute time between APU start sequence and engine shutdown.* According to his statement the captain was aware of the new recommendation. However, the co-pilot did not remember it at the time of his interview. If taxi time is short it easily results in having to wait at the stand with one or both engines running, so as to allow for the 1 minute between APU start sequence and engine shutdown. According to the SOP it is the task of the co-pilot to start the APU. However, the captain said that he – and possibly other captains in the company as well – have taken the habit of turning the APU start switch to the ON position, or even starting the APU during taxiing, so as to minimize any possible wait. During his interview the captain said that he had turned the APU switch to the ON position so as to expedite the start; he did not mention this to the co-pilot. During interviews, both pilots assumed that the problems with the APU's start were partly caused by the captain's involvement in the process. While the investigation could not establish all pilot action with regard to the APU's start, the APU's FADEC (Full Authority Digital Engine Control) data showed that it started on the first try. According to the aircraft manufacturer the FADEC ignores a new start attempt when the APU is either spooling up or already running.

The aircraft's warning system EICAS signalled an APU caution after its first start. In the Occurrence Report the captain stated that the caution was APU GEN FAIL. However, the warning system does not include any such caution. During his interview the captain assumed that the caution was APU FAIL. This, too, is unlikely because the APU FAIL caution is given in situations in which the APU has automatically shut down. In this case the APU was still running.

While the EICAS does not record its cautions or warnings into its own memory, Central Maintenance Computer data revealed that the malfunction related to the APU's first start was APU GCU FAIL (APU Generator Control Unit Failure). This can happen for several reasons. Although the EICAS does not signal the failure as such, the aircraft manufacturer believes that the caution related to the occurrence was probably APU GEN OFF BUS. The investigation could not establish the cause for the APU GCU FAIL. The APU GCU, APU STARTER/GENERATOR and FADEC in use on the aircraft at the time of the incident also remained on the aircraft after the APU was replaced. No malfunctions have since been detected.

Once the captain noticed on the MFD (Multifunction Display) electric system page that the APU generator had failed to couple to the aircraft's electric system he tried to reset it during taxiing, but to no avail. He initiated the procedures without using the checklist. Evidently the pilots did not discuss the situation before the captain began to act. After the reset failed the captain told the co-pilot to shut down and restart the APU. There is a checklist for the APU GEN OFF BUS caution and the pilots should have followed it. The checklist in question also calls for generator reset and, therefore, the captain's action was not incorrect. The pilots hurried in handling the situation and deviated from the SOP. They neither used nor followed the appropriate checklist and, as the captain taxied the aircraft, the co-pilot should have taken the measures required by the EICAS caution. OM-B 3.3 provides instructions on the division of duties between pilots as well as measures for situations when the EICAS signals cautions and warnings.

The pilots' decision to shut down and restart the APU was not based on any published recommendations or SOPs. Instead, it was based on the captain's own judgement. While the procedure was not erroneous *per se*, the manner in which it was handled only led to further trouble. The captain, as per his account, said that he did not follow the APU's spooling down when he told the co-pilot to restart it. The co-pilot said that he asked the captain twice whether he really wanted to start the APU while it was spooling down and still turning. During his interview the captain said that he remembered the co-pilot asking him about the APU start, but according to him the co-pilot had not clearly informed him that the APU was still turning. When the captain answered affirmatively, the co-pilot tried to start the APU. Recorded data shows that the APU did not start on the second attempt. The FADEC's fault data FAIL TO CRANK during the start sequence means that the APU's RPM is three percent or less after eight seconds from the start signal, i.e. the APU has failed to start. The fault data in question results in an automatic APU shutdown. FADEC records show that the exhaust gas temperature (EGT) was on the high side when the fault appeared; this is because it had not completely cooled down from previous use.

When the left engine was simultaneously shut down with the second APU start attempt, the overcurrent protection feature activated. Because of this some of the buses fed by the left engine's generators were left without power. The aircraft manufacturer had published recommendations intended to avoid this situation and on how to handle one, should it occur (Operational Bulletin 145-004/06; Electrical loads loss associated with engines shut down). The Aircraft Operating Manual (AOM) procedures had also been revised with regard to the topic. The changes were published on 30.11.2007 in AOM revision #34. Finnish Commuter Airlines E-145 OM-B procedures had not been changed as per the AOM revision. The company informed AIB that the Operational Bulletin was disseminated to the pilots and that the subject matter was also discussed during refresher training sessions. The pilots did not comply with the Operational Bulletin's recommendations, the APU starter motor limitations published in the OM-B (OM-B 1.3.4.2) nor the recommendation to allow 1 minute time between APU start sequence and engine shutdown (OM-B 2.1.20.1).

The pilots were evidently giving their full attention to the EICAS warnings and cautions caused by overcurrent protection feature activation and, therefore, they probably were not monitoring the APU start. They did not follow checklists in responding to EICAS warnings and cautions because they thought that it would have been almost impossible, due to the large number of warnings and cautions. Neither did they notice that the loadmaster outside the aircraft tried to get their attention with regard to the fire that was detected at the back of the plane. The investigation could not establish which warnings and cautions the EICAS displayed after the left engine was shut down.

After the right engine was shut down, the aircraft lost almost all electrical power and the EICAS signalled several new warnings and cautions. After the cabin door was opened the loadmaster told the pilots about the fire he had detected at the back of the aircraft. Since no fire alarm had been signalled in the cockpit, the captain went out to see for himself. After having seen the smoke and been told of visible flames the captain returned to the flight deck and discharged the APU fire extinguisher bottle. The investigators consider it unusual that, during the course of events, neither pilot reported the suspected or detected fire to air traffic control, nor tried to alert fire units to the aircraft.

In the Occurrence Report and during his interview the captain said that it was not his intention to discharge the fire extinguisher bottle. Instead, he meant to cut off the fuel feed to the APU. According to his statement he did not consider the incidence a real fire but rather only that fuel had got into the APU tailpipe and was burning off. It is obvious that the pilots did not discuss the fire before the captain acted. The captain discharged the APU fire extinguisher bottle himself while standing in the cockpit, even though it would have been easier for the seated co-pilot to do this at the behest of the captain. The fact that they had not received a fire warning made the situation much more difficult for them. The E-145 OM-B (QRH EAP 3-3) fire warning checklist contains the two following procedures that have to be memorized: *APU Fuel Shutoff Valve ... PUSHED IN and APU Master Knob ... OFF*. In a difficult situation the captain decided to act as best he could by relying on his memory and by cutting off the fuel feed to the APU. However, according to his account, he selected the wrong switch on the overhead panel. The discharge of the extinguisher bottle also cut off the fuel feed to the APU and, as a result, put out the fire. Once the fire was extinguished the pilots concentrated on solving the electrical problem and no longer took into account the fire or its possible consequences.

The pilots could not manually turn off all of the electrical power from the flight deck. Only when they disconnected the battery leads did they manage to turn all the power off. In doing this they had to complete a procedure for which they were not qualified (OM-A 8.1.12.2.2: *With the exception CB reset or computer reboot or other similar actions described in associated OM-B, flight crew members are not entitled to perform corrective actions*). On the evening of the occurrence no normal entries with regard to the flight or records of faults or events at Kemi-Tornio airport were made into the aircraft's journey logbook. Only on the following day when the technical personnel had already arrived did the captain complete the logbook, but he did not enter any information related to the APU fire, disconnecting battery leads, filing an OR report or about a need to save flight recorder (FDR, CVR) data.



Figure 4. FIRE and APU CONTROL

At the time of the incident the pilots' shift had lasted approximately nine and a half hours. It was their fifth and final flight of the day. The crew intended to stay overnight at Kemi-Tornio airport and fly back to Helsinki in the morning. Since the rest period ahead was going to be brief, they might have been hurrying in order to be able to start resting sooner. Since this was the third time they had arrived in Kemi that day, it may have felt so routine that their concentration and alertness were lowered. The rather long working day and the late hour could also have affected their performance.

The pilots communicated with each other in English. While SOP-based communication is always done in English the co-pilot said that, depending on the captain, he uses either Finnish or English in other conversations. The investigators believe it possible that the use of a language which is not the mother tongue of either pilot could have adversely contributed to the action taken on the flight deck in an urgent and exceptional situation.

The pilots felt that they had no problems with Multi-Crew Coordination (MCC). Nonetheless, the investigators believe that the manner in which the pilots acted and, especially, how they handled the APU start up and the fire points to shortcomings in MCC and communication between the pilots. It seems as if the pilots acted as two individuals rather than together as a crew. Moreover, they did not entirely comply with the OM-B and SOPs. The underlying tone of MCC during the course of events was hurried which, according to the investigators, contributed to deviating from SOPs and to degraded MCC.

During the investigation the cabin attendant was interviewed. She assumed that the pilots did not at first provide any information or instructions with regard to the fire because they assumed that the passengers would exit the aircraft soon and safely enough without a separate command anyway. Had the pilots given the cabin attendant even preliminary information of the situation she would have been better prepared to act quickly. She could have also acted on her own initiative had the situation significantly deteriorated. From her position at the front of the aircraft she could see the entire cabin and to the outside of the aircraft through the passenger door. This being the case, she was in a position to judge the severity of the situation herself as well as any measures possibly required in the cabin.

2.2 APU fire

The pilots tried to restart the APU too soon after shutting it down. A tailpipe fire occurred between the shutdown and the attempted restart. This was probably caused by premature ignition of fuel left in the combustion chamber during the restart. The fuel did not have enough time to leave the combustion chamber through a drain pipe. According to eyewitness accounts a long flame shot out of the APU tailpipe. Flame backflow entered the APU compartment through the vent between the muffled tailpipe and the APU compartment. Judging by the damage and burn marks it was decided that only fuel had burned. Since the investigation found no fuel system leaks, the fuel that burned was kerosene fed into the APU combustion chamber, possibly making it to the tailpipe from there.

The APU fire detection system is powered by a bus which, according to DFDR data, was powered up throughout the incident until the batteries were disconnected. Nevertheless, the APU's fire detection system did not signal a fire warning to the pilots. During the investigation the aircraft's fire detection system was tested and related values were measured. The APU's fire detector sensing element was sent to its manufacturer for testing. The purpose of the tests was to ensure that the element in question operated as it was designed to and to assess whether its design features provide a sufficiently rapid warning in a fire. The APU's fire detector sensing element passed all of the authorities' minimum requirements. However, the *Low Discrete Test* did not result in fire detection at one point of the sensing element. Neither did a retest at a higher temperature at the same point pass. The Low Discrete test was retaken at several other points on the fire detector sensing element. No other faults were detected. No shortcomings were discovered in the other parts of the APU's fire detection system during the investigation.

The flames that reached the APU compartment varied in strength. Other wiring and equipment parts between the flames and the fire detector sensing element reduced the exposure of the element. Since it was impossible to establish the conditions during the fire accurately enough, it is not possible to prove why a fire warning was not signalled. According to the test results it is possible that the fire detector sensing element may have partially functioned defectively in the incident. However, it is more likely that the sensing element was not exposed to sufficient heat at an adequately long distance. The investigators believe that analysis should be done on whether the E-145's APU fire detection system design is sensitive enough, because the flames that touched the fire detector sensing element in the APU compartment did not trigger a fire alarm. The

investigators do not consider it good that the vent between the APU's muffled tailpipe and the APU compartment enables flames to enter the APU compartment.

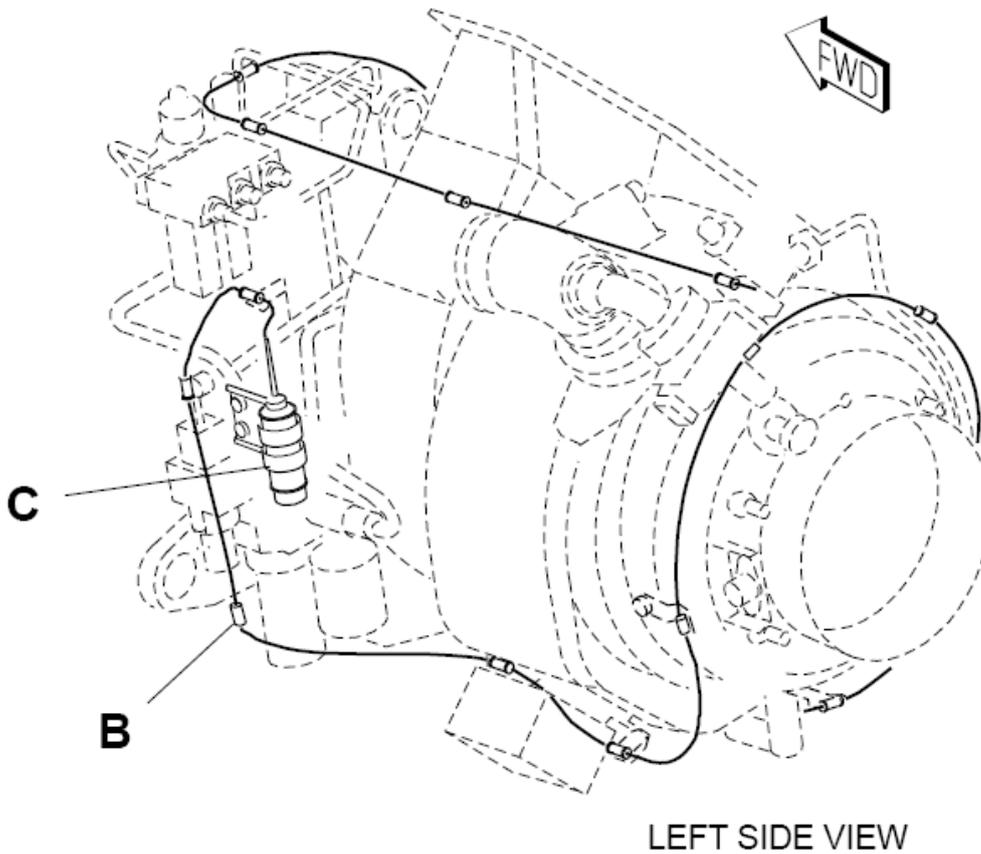


Figure 5. APU fire detector sensing element assembly (AMM)

The investigators estimated that the fire lasted at least a minute and a half. However, due to good fire protection, the small amount of combustible material in the APU compartment as well as the small amount of fuel that burned it did not cause major damage to the surroundings. The APU compartment is designated as a FIRE ZONE and, therefore, it must have fire detection and suppression systems. A possible fire in this space may not impact any other structures and parts on the aircraft. Hence, there is a fire tolerating titanium firewall between the APU compartment and the fuselage. The inner surfaces of the protection plates around the space are also titanium coated. The melting point of titanium is 1870 °C.

The investigators requested information from the E-145's manufacturer with regard to APU fires. There were 19 such recorded instances. No apparent common cause for them could be established. In some of the instances there was no mention whether a warning was signalled or not. In some instances the system signalled a fire warning but no signs of a fire were found. Conversely, in two instances there were signs of a fire but the fire warning system did not signal a warning. In its comments to the draft final report the aircraft manufacturer's opinion is that the two abovementioned occurrences did not involve actual APU fires. The aircraft manufacturer's entire comments are appended to this investigation report.

A fire on an aircraft is always classified as an incident. The severity of this incident was exacerbated by the simultaneous occurrence of several faults that affect the operation of the aircraft. Had the APU fire warning been signalled, it would have made the pilots' action significantly easier in this incident.

2.3 Reporting of the incident

Neither pilot reported the fire to the air traffic control. Although the situation was probably confusing and things happened in rapid succession it is remarkable that even after the fire was detected and extinguished they did not contact the ATC. According to their statements, the pilots did not report anything to the ATC because they did not consider the occurrence a real fire. Pilots should report safety related occurrences to the air traffic control so as to guarantee the ATC's appropriate attention and alerting service for the flight.

The pilots reported the events as technical malfunctions to the airline and the authorities. There was a shortcoming in the company's reporting instructions which delayed the informing of AIB Finland of the occurrence. Once this was noticed, it was immediately rectified. The company's OM-A includes instructions on incident reporting. It is obvious that the examples of reportable occurrences related to aircraft operations included in the OM-A cannot cover all serious incidents. Therefore, the severity assessment of incidents and occurrences is left to the discretion of pilots.

The cabin attendant did not file a cabin safety report. She was not immediately informed of the incident. Nor did she afterward consider the situation dangerous enough to flight safety to warrant a report. Company manuals do not provide instructions on cabin safety reporting.

The air traffic controller did not notice the incident, nor were they informed of it before the end of the shift. Therefore, the ATC controller did not record the occurrence in the ATC logbook, nor did they file a PHI safety report for Finavia or the authorities. The maintenance and rescue personnel at Kemi-Tornio aerodrome are also required to file PHI reports for Finavia. The standardized procedures of the PHI reporting system are explained in detail in Finavia's Safety Management Systems (SMS) Manual, Appendix C.

The ground handling agent's personnel did not file a flight safety incident report. They said that they were unaware of any such obligation. The ground handling company should ensure that their personnel are aware of regulations that govern the reporting of accidents, serious incidents and occurrences.

Finland's national aviation regulation GEN M1-4 is based on international rules and conventions. It governs the reporting of accidents, serious incidents and occurrences. Pursuant to this regulation, the pilots, the ATC controller and the aerodrome emergency personnel as well as the ground handling company's loading personnel were under obligation to report this incident. A well functioning reporting system makes it easier for each organisation to detect safety and quality related shortcomings as well as identify needs for improvement. In addition, the launching of accident or incident investigations

as well as securing relevant material requires that reporting be done according to the regulations.

2.4 Ground crew action

Kemi-Tornio ATC was about to close when alerting service was needed due to the incident. This situation was made possible by the simultaneous closing time of the airport and the air traffic control. Even though an aircraft taxiing on the apron is no longer the ATC controller's responsibility, the fact that the ATC closed and alerting service ended before the passengers deplaned exacerbated the severity of this incident. It is the opinion of the investigators that, for flight safety reasons, the ATC should not have closed before the passengers had exited the aircraft. The investigation revealed that Kemi-Tornio does not have detailed instructions on closing the ATC. According to information received, such instructions are now being prepared.

The rescue unit was on location to cover the landing of the flight. Since the shift of the rescue personnel was ending at 22:55 they returned to the rescue station after the landing. Subsequent to that, the rescue personnel detected the flames at the back of the aircraft. Neither the ATC nor the pilots called the rescue units to the aircraft at any stage. However, the rescue personnel went to the aircraft to inspect the situation after the fire had been extinguished and the passengers deplaned. The fact that there was no alert slowed the rescue units' response to the situation. According to the rescue personnel's statement, it is quite commonplace to see flames shooting out of an APU and, therefore, they saw no need to report the occurrence. The investigators believe that the rescue personnel probably detected the fire only after it was dying down as otherwise, according to the eyewitness descriptions, it would not have been regarded as commonplace. This incident deviated so much from normal operations that a report should have been made.

Apart from not filing a flight safety report with regard to the incident, the ground handling agent's personnel complied with regulations.

2.5 Maintenance action

The mechanics that arrived at Kemi-Tornio aerodrome received information on the faults from the airline and the pilots. However, the fire, which the ground handlers detected and reported to the pilots and which the captain himself went out to confirm, was not reported to the mechanics. The electric system was restored and, as far as this system was concerned, the aircraft was pronounced airworthy. A visual inspection of the APU and its immediate surroundings detected signs of a fire, although with no damage. Given that the APU fire extinguisher bottle had been discharged the APU was deactivated in accordance with the manner prescribed in the aircraft's Minimum Equipment List (MEL). Subsequently, it was decided that the aircraft was again airworthy.

Maintenance regulations-mandated inspections regarding the situation were not made prior to the ferry flight. The insufficient information the mechanics received from the company and the pilots may have contributed to this. The mechanics were not informed of the fire, nor were there any records in the aircraft's technical logbook about the

matter. In addition, working conditions at Kemi-Tornio were challenging; there was no scaffolding for the purpose of thoroughly inspecting the APU and the lighting in the hangar was dim. Even though the mechanics did detect signs of a fire in the APU compartment, they did not see any need for further inspection. The inspections made in Helsinki after the ferry flight should have already been made in Kemi because, at that time, the effect of the damage on airworthiness was not yet established.

After the ferry flight inspections were made in accordance with the SRM and AMM. Heat induced damage was detected on the APU and its cowling. The aircraft was grounded until the manufacturer could comment on the aircraft's airworthiness. The operator requested and received instructions from the aircraft manufacturer on the required measures. The inspections made in Helsinki as well as the subsequent measures to ensure the aircraft's airworthiness were comprehensive and sufficient.

The repair report on the APU that was removed from the aircraft following the incident stated that the APU had already been in poor condition and partly damaged before the fire. Furthermore, copious white residue was found inside the APU. The residue was probably that of de-icing liquid. APU power was degraded, the volume of bleed air was too low and the exhaust gas temperature (EGT) was too high. The investigation could not prove any correlation between the repair report's findings and the failure (APU GCU FAIL) during the first start, the failed second start attempt or the fire itself. According to the aircraft manufacturer the basic reason for the failed second start of the APU was the fact that the EGT sensor wire had melted in the fire. The APU's fire detector sensing element was replaced at the same time as the APU. The old sensing element that was sent to the factory for testing was discarded.

3 CONCLUSIONS

3.1 Findings

1. The pilots had valid licences and the required ratings.
2. The certificate of registration and the airworthiness certificate were valid.
3. The flight landed at Kemi-Tornio aerodrome eight minutes before the scheduled closing time of the airport and the air traffic control.
4. The flight from Helsinki to Kemi-Tornio was uneventful until landing.
5. After landing the APU was started but the generator did not couple to the aircraft's electrical system despite a reset attempt.
6. The pilots decided to shut down and restart the APU in order to couple the generator to the electrical system.
7. At the same time as the second start attempt, a fire broke out in the APU. However, no fire warning was displayed in the cockpit. The APU did not start on the second attempt.
8. As the left engine was being shut down the electrical system's overcurrent protection feature activated, leaving some of the buses without power.
9. After the right engine was shut down the aircraft lost almost all electrical power.
10. The pilots did not notice a ground crew loadmaster trying to inform them using official hand signals of the fire.
11. Immediately after the cabin door was opened the loadmaster came into the cockpit to report the fire.
12. Since no fire warning was displayed in the cockpit, the captain went out to inspect the situation.
13. After having returned to the cockpit the captain discharged the APU fire extinguisher bottle, which put the fire out.
14. Neither the cabin attendant nor the passengers were informed by the pilots of the fire. The passengers deplaned in nearly normal fashion during the fire.
15. Once the fire was out, the pilots concentrated on the electrical problem.
16. The air traffic controller was not informed of the fire, nor did the controller notice it.
17. After the fire had been extinguished the aerodrome's rescue unit came to the aircraft to observe the situation.

18. The burned APU was not inspected before the aircraft was towed to hangar for the night.
19. The pilots reported the events to the company and requested technical assistance for the following day.
20. The pilots did not record all of the faults or occurrences in the aircraft's technical logbook.
21. The mechanics restored the electrical system, made a visual inspection of the APU and deactivated the APU in accordance with the manner prescribed in the aircraft's Minimum Equipment List (MEL). After this, the aircraft was pronounced airworthy again.
22. After the ferry flight to Helsinki inspections were made in accordance with regulations. Heat induced damage was found and the aircraft was grounded.
23. The requested instructions were received from the aircraft manufacturer for making the aircraft airworthy again.
24. After the ferry flight to Helsinki the pilots filed an Occurrence Report with the company and the authorities. No other flight safety reports were filed.
25. AIB Finland was informed of the incident over three days after its occurrence.
26. In 2007 the aircraft manufacturer published an AOM revision which includes changes and instructions for pilots with regard to overcurrent protection feature activation.
27. The airline had informed its pilots of the possibility of the overcurrent protection feature activation. However, the changes as per the AOM revision were not made in the OM-B.
28. The APU's fire detection system did not trigger a fire warning even though the flames made contact with the fire detector sensing element.
29. When tested, the APU's fire detector sensing element met all of the authorities' requirements and, apart from one test, it passed all tests included in the element manufacturer's testing regime. The sensing element's insufficient exposure to the flames was probably the cause of the absent fire warning.
30. The fact that there was no fire warning made the situation much more difficult for the pilots in this incident.
31. Inspections revealed that the APU had already been in poor condition and partly damaged before the fire. Its performance was also degraded.
32. The investigation could not prove correlation between the APU's poor condition and the failure (APU GCU FAIL), the failed second start attempt or the fire.

33. The investigation exposed shortcomings in the pilots' mutual communication, Multi-Crew Coordination and compliance with SOPs.
34. Pursuant to ICAO Annex 13 the occurrence was a Serious Incident: *Multiple malfunctions of one or more aircraft systems seriously affecting the operation of the aircraft.*

3.2 Contributing factors

The incident occurred when the aircraft's APU caught fire while taxiing to stand after landing. The flames made it to the APU's tailpipe and the APU compartment. At first the pilots did not notice the fire because the onboard warning system did not signal a fire warning. The ground crew informed the pilots of the fire. When the fire started the passengers were still onboard and they deplaned while the fire was burning.

Several simultaneously occurring faults affecting the aircraft's operation exacerbated the severity of the incident. The pilots were occupied with the APU generator's coupling failure, the unexpected activation of the overcurrent protection feature and the failed APU start. These held their attention and slowed their response to the fire. The power failure also made the cabin attendant's work more difficult, slowing down passenger exit as normal cabin lighting was off. The fact that the pilots did not comply with the aircraft manufacturer's instructions relating to the matter contributed to the overcurrent protection feature activation. The air traffic control did not notice the fire, nor was it informed of its occurrence. No alarm was given, nor did the emergency unit on site react to the situation during the fire.

4 RECOMMENDATIONS

1. The investigation revealed that the APU fire detection system did not trigger a fire alarm even though the fire detector sensing element was exposed to flames.

The aircraft manufacturer is advised to ensure that the APU fire detection systems on the E-145 aircraft display fire alarms in a sufficiently precise and reliable manner in different kinds of fire situations.

2. The investigation revealed that the airline had not included the aircraft manufacturer's overcurrent protection feature AOM revisions in its E-145 OM-B.

The airline is advised to always ensure that the manufacturer's AOM revisions are included in its OM-B.

3. The investigation revealed that the mechanics did not receive all pertinent information with regard to the aircraft's faults and airworthiness after the incident.

The airline is advised to ensure that the pilots record all appropriate information in the aircraft technical logbook with regard to faults, incidents and observations that may impact flight safety or an aircraft's airworthiness.

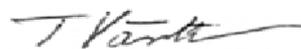
4. The investigation revealed shortcomings in Multi-Crew Coordination as well as in compliance with Standard Operating Procedures and the OM-B.

The airline is advised to guarantee their aircrews' Multi-Crew Coordination competence as well as their capability to operate in accordance with company manuals.

Helsinki 2.2.2010

Handwritten signature of Markus Bergman in black ink.

Markus Bergman

Handwritten signature of Tapani Vanttinen in black ink.

Tapani Vanttinen

Handwritten signature of Sanna Winberg in black ink.

Sanna Winberg



FLIGHT
OPERATIONS

Accident Investigation Board Finland
Sörnäisten rantatie 33 C
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7.12.2009

STATEMENT REQUEST 387/5L

We thank you for possibility to comment Final Draft of Investigation Report C8/2008L (12.10.2009) and the given expansion for the commenting schedule.

We have carefully studied the Final Draft and the incident and following to that we would like to state following in relation to the statements in the draft:

1) Pilots' knowledge regarding fire

Because of the missing fire alarm, the pilots didn't find out during the incident or after it that there was a fire in APU. The understanding of pilots was that it was fuel remaining in the outflow pipe that was burning and for which they saw as best action to cut the fuel flow. The normality of the situation is pinpointed in our opinion by rescue personnel's statement that the flames were common and the fact that they didn't spontaneously start rescue operation during the fire.

Because of this same reason, neither ATC nor ground personnel were not informed.

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2) Information received by mechanic and mechanic's observations in Kemi

The pilots were not aware of actual APU fire, instead their understanding the case was just an accidental launching of fire bottle. Therefore the pilots were unable to inform mechanic about the fire or to write it down to technical log book.

Based on the internal discussions with the mechanic, it has come clear the he didn't conclude in Kemi that there would have been an APU fire. Mechanic's view is that the smoke trails outside APU were corresponding to ones that appear in normal operation (e.g. caused by de-icing fluids ended to APU during de-icing process).

Because of the mechanic's opinion was that there wasn't any need to perform the tasks required after APU fire in Kemi because there wasn't information regarding actual fire.

Based on the above mentioned, our opinion is that statements regarding mechanic's findings regarding a fire and lack of knowledge given by the pilots are inaccurate.

3) Safety recommendation 3 " ...mechanics did not receive all needed information after incident..."

Our opinion is that mechanic was given all information the pilots had either verbally or over phone. Markings regarding the faults in pilots' knowledge were not completed to the technical log that may have been impacted by the fact that the pilots started to find out the organization of the flight of next morning that interrupted the normal working flow. According to the company's operation manual, these should have been written to the technical logbook.

4) Safety recommendation 4 "During investigation lack in CRM and following of SOPs and OM-B instructions were noted"

Missing fire alarm significantly complicated crew's actions in situation that in our opinion had a significant contribution towards handling the situation. If the fire alarm would have actualized, it would be presumable that the crew would have acted in accordance with the SOP required by a fire.

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Malfunction of electrical system significantly complicated the work of pilots as it resulted that normal lightning in the cockpit was not usable. In the prevailing situation, pilots were aware of malfunction of electrical system and ground persons mention regarding APU fire. Captain reaffirmed the fire information visually and his judgment was that it wasn't an actual fire. There is no SOP available in situation, where the crew leaves its working position and there are several faults present and a fault where no indication exists. Because of that our opinion is that there is not a SOP available regarding the fire as the fire indication was missing and therefore it shall not be stated that there were problems completing the SOP.

Our opinion is also that there wasn't lack of co-operation between flight and cabin crew when it is taken into account that flight crew's understanding was that there wasn't any fire. Flight crew informed cabin crew about the electrical problems that were the only fault they were aware of.

5) Preserving CVR recordings

Our opinion is that as the flight crew was unaware of the fire the CVR recording was not preserved as sole accidental launching of fire bottle was not seen as a reason to preserve the recording in accordance with company's OM-A.

6) Cabin safety reporting

Company's reporting system has been created to fulfill requirements of OPS 1.420 that don't require cabin safety reporting. We have tried to make company's reporting system as simple as possible and therefore also out cabin crew reports using the same reporting system (either Occurrence or Quality reports).

7) Opening hours of ATC

Our company would like to present its concern regarding quick closure time after landing presented in the report. Significant portion of our flights are scheduled to arrive only minutes before closing of ATC.

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We will respond to the safety recommendations when the final report has been published.

Kind regards,

Finnish Commuter Airlines Oy

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SUBJECT: E-145 APU fire incident in Finland. Final Draft Report. Request for comments

OUR REF:

A/C TYPE: ERJ-145

REFERENCES: draft final report C8/2008L

You will find below our comments of the draft final report C8/2008L:

In the page 16, second paragraph:

*" The investigators requested information from the E-145's manufacturer with regard to APU fires. There were 19 such recorded instances. No apparent common cause for them could be established . **In two instances there were signs of a fire but the fire warning system did not signal a warning** . In some of the instances there was no mention whether a warning was signaled or not. On the other hand, in some instances the system signaled a fire warning but no signs of a fire were found ."*

According mail in 20.Nov.2009, the investigator-in-charge regards the two hazard reports as occurrences with signs of fire without a fire warning:

- Oc0768-2003 (file OC4521ctpj[1].pdf):

" DURING AN APU START FOR FLIGHT 4331 FROM MTX (MARQUETTE - USA - MICHIGAN), THE FLIGHT CREW REPORTED A HUNG START AT 25%. THE GROUND CREW ALSO NOTICED FIRE IN THE APU EXHAUST. MAINTENANCE PERSONNEL REMOVED AND REPLACED THE FADEC ASSEMBLY, AS WELL THE W317 HARNESS AND DRAIN LINE. THE FADEC WAS REPORTED TO BE THE MAIN PROBLEM, AS THEY WERE ABLE TO DUPLICATE THE PROBLEM ."

- Oc424-2001 (OC872sirn[1].pdf)

"DURING MAINTENANCE TROUBLESHOOTING AT BASE HANGAR IN FAYETTEVILLE/SPRINGDALE, AR - USA (XNA) FOR APU INOP ON MEL, IT WAS NOTED FUEL LEAK AT THE BOTTOM OF APU COWL. FURTHER INVESTIGATION REVEALED START NOZZLE FUEL LINE CHAFED THROUGH BY FIRE LOOP WIRE. ALSO WAS NOTED SOME BURN MARKS IN THE COWL AREA (INSIDE) AND OUTSIDE OF COWL AREA THE PAINT WAS MISSING."

These events occurred respectively in 2003 and 2001, and we don't have more information about it.

The Embraer engineering believes that the Oc0768-2003 was a torching in the APU exhausted duct, and not in the cowling region where the fire sensor was installed. The torching could be caused by an incorrect operational procedure, once that following every APU start attempt is necessary to allow 3 minutes of APU warm-up before adding pneumatic load. This is particularly important after unsuccessful APU start attempts, so as to permit

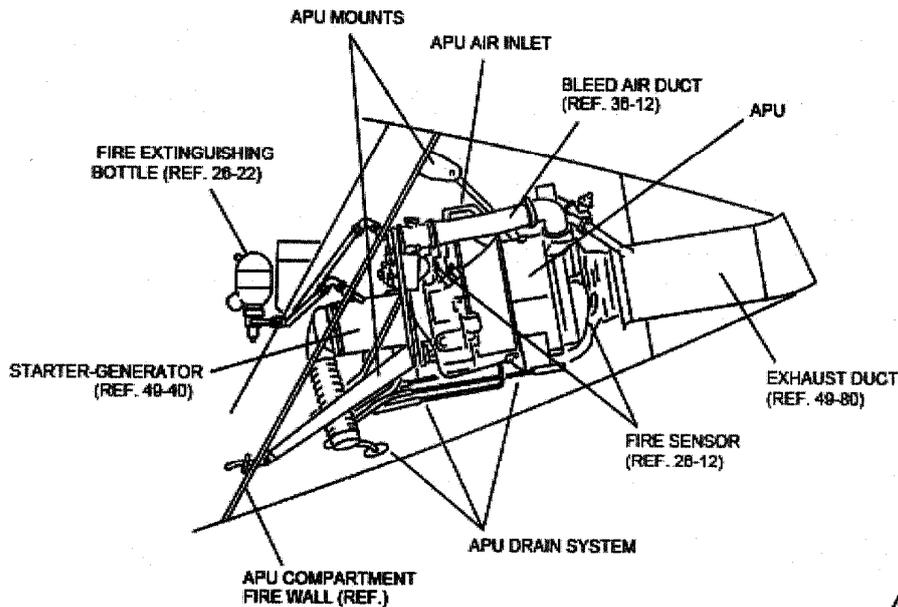
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that excessive fuel accumulated during the previous start attempts is burned. Therefore Embraer engineering believes this should not be classified as "APU FIRE" but as torching during start.

Oc424-2001 does not mention if a APU FIRE message was displayed or not. Unfortunately, since this event happened in 2001, we were unable to clarify this point. Therefore Embraer engineering believes this should not be classified as a case of fire with no warning.

We respectfully suggest that the following statement be revised:

In two instances there were signs of a fire but the fire warning system did not signal a warning .



We would like to thank you for the opportunity to review this final report.

Best regards,

Fabien BONNASSIE

Air Safety Manager

Embraer – Embraer Aviation International