Investigation report

C5/2010L

Serious incident at Helsinki-Vantaa Airport on 12 June 2010

Translation of the original Finnish report

OH-SAR

AVRO 146-RJ85

Onnettomuustutkintakeskus
Centralen för undersökning av olyckor
Accident Investigation Board

Osoite / Address: Sörnäisten rantatie 33 C
FIN-00500 HELSINKI

Adress: Sörnäs strandväg 33 C
00500 HELSINGFORS

Puhelin / Telefon: (09) 1606 7643
Telephone: +358 9 1606 7643

Fax: (09) 1606 7811
Fax: +358 9 1606 7811

Sähköposti: onnettomuustutkinta@om.fi tai etunimi.sukunimi@om.fi
E-post: onnettomuustutkinta@om.fi eller förnamn.släktnamn@om.fi
Email: onnettomuustutkinta@om.fi or first name.last name@om.fi

Internet: www.onnettomuustutkinta.fi

Henkilöstö / Personal / Personnel:

Johtaja / Direktör / Director	Veli-Pekka Nurmi
Hallintopäällikkö / Förvaltningsdirektör / Administrative Director	Pirjo Valkama-Joutsen
Osastosihteeri / Avdelningssekreterare / Assistant	Sini Järvi
Toimistosihteeri / Byråsekreterare / Assistant	Leena Leskelä
Ilmailuonnettomuudet / Flygolyckor / Aviation accidents	
Johtava tutkija / Ledande utredare / Chief Air Accident Investigator	Vacant
Erikoistutkija / Utredare / Air Accident Investigator	Tii-Maria Siitonen
Raideliikenneonnettomuudet / Spårtrafikolyckor / Rail accidents	
Johtava tutkija / Ledande utredare / Chief Rail Accident Investigator	Esko Värttiö
Erikoistutkija / Utredare / Rail Accident Investigator	Reijo Mynttinen
Vesiliikenneonnettomuudet / Sjöfartsolyckor / Marine accidents	
Johtava tutkija / Ledande utredare / Chief Marine Accident Investigator	Martti Heikkilä
Erikoistutkija / Utredare / Marine Accident Investigator	Risto Repo
Muut onnettomuudet / Övriga olyckor / Other accidents	
Johtava tutkija / Ledande utredare / Chief Accident Investigator	Kai Valonen

SUMMARY

On 12 June 2010 an AVRO 146-RJ85 airliner, registered OH-SAR and operated by Blue1 Ltd on flight number BLF639, suffered severe engine damage during take-off run at Helsinki-Vantaa Airport runway 22R. The pilots aborted take-off at 03:47 UTC. As a result of the engine damage, a significant amount of engine pieces was left on the runway. A serious incident occurred as two transport aircraft were cleared for take-off from the same runway before the engine pieces were removed. There were 93 passengers and 4 crew members on board of OH-SAR. No one was injured in the incident.

After OH-SAR had vacated the runway, a runway inspection was carried out by one airport maintenance worker at the air traffic control's request. The runway was reported to be free of obstacles, and the controller cleared two transport aircraft for take-off from the same runway. After that, the pilot-in-command of OH-SAR contacted the air traffic control by telephone and told about the severe nature of the engine damage. For this reason, the controller requested a new runway inspection, specifying the area to be inspected and what should be looked for. The inspection was conducted by two airport maintenance staff members and two cars. This time, engine pieces were found on the runway. The runway was swept before the next aircraft took off. The crews of the two transport aircraft which took off from the runway after the first inspection were informed of the situation through Tallinn ATC.

The instructions of Blue1 Ltd concerning pilot actions in the event of aborted take-off were found to be adequate. It was concluded that the engine damage resulted from a fatigue fracture in the root of a second-stage turbine rotor blade, which was probably caused by overheat in the engine although other causes could not be excluded. The fracture could not be predicted on the basis of current engine condition monitoring procedures, which showed no difference between the damaged engine and the other engines. Engine maintenance actions had been signed as having been performed properly and on time, without exceeding any service life limitations.

A serious incident developed because two transport aircraft were cleared for take-off while there were engine pieces on the runway, which could have damaged the aircraft during take-off run. The engine pieces remained on the runway, since they were not found in the first runway inspection carried out after the aborted take-off. The first runway inspection failed partly because any detailed assessment about the nature and location of the incident was not given in conjunction with the inspection request, and the airport maintenance unit therefore did not see any specific reason to inspect the runway more thoroughly than usual. The ATC actions when asking for runway inspection and providing related information to the airport maintenance unit were in accordance with the instructions and established practices at the aerodrome.

Based on the investigation, the investigation commission recommends the Finnish airport operator Finavia Corporation to make the instructions for runway inspections more specific, so that the inspecting staff would have all available necessary information about the situation at their disposal during the inspection. Secondly, Finavia Corporation is recommended to find out whether any technology suitable for the local conditions is available for detecting foreign objects on the runway and, based on studies, decide on the necessity of obtaining such equipment. The Aviation Sector of the Finnish Transport Safety Agency (Trafi) is recommended to examine the instruc-

tions provided by air carriers operating in Finland to their technical staff in cases where aircraft parts may remain on the runway and the ATC should be informed about that without delay.

Based on the investigation, the commission also suggests that Finavia Corporation increase regular and continuous co-operation between ATC and airport maintenance unit operations staff at all of its airports.

TABLE OF CONTENTS

ABBREVIATIONS

AAIB	Air Accidents Investigation Branch
ACC	Area Control Centre
AD	Airworthiness Directive
AFIS	Aerodrome Flight Information Service
APP	Approach Control
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
CSN	Cycles Since New
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
EASA	European Aviation Safety Agency
EFHK	Helsinki-Vantaa Airport (ICAO)
EFHK-KK	Helsinki-Vantaa Airport maintenance unit
EGT	Exhaust Gas Temperature
FOD	Foreign Object Damage
GPL	Glider Pilot Licence
ICAO	International Civil Aviation Organisation
JAR	Joint Aviation Requirements
L	Left
LJKK	Air Traffic Controller's Handbook
LVP	Low Visibility Procedures

PF	Pilot Flying
PNF	Pilot Non-Flying
PPL	Private Pilot Licence
R	Right
SB	Service Bulletin
TOGA	Takeoff and go-around
TSN	Time Since New
Trafi	Finnish Transport Safety Agency
UK	United Kingdom
UTC	Co-ordinated Universal Time
V1	Decision Speed

SYNOPSIS

A serious incident occurred at Helsinki-Vantaa Airport on 12 June 2010. The outer left engine of an AVRO 146-RJ85 airliner, registered OH-SAR and operated by Blue1 Ltd on scheduled flight BLF639 from Helsinki to Copenhagen, was damaged during take-off run. The crew aborted the take-off. No persons were injured in this incident.

A runway inspection was made after the aircraft had vacated the runway. When it came out that parts were missing from the damaged engine, the runway was inspected again. During the second inspection, several metal parts were detected on the runway and the runway was cleaned by sweeping. Two transport aircraft were allowed to take off from the same runway between the first and second runway inspection.

The pilot-in-command filed a report about the serious incident in accordance with company instructions. The air traffic control and airport maintenance unit also submitted reports as required by the aviation authority.

The incident was classified as a serious incident, because two transport aircraft took off from a runway which should have been closed as unfit for movement of aircraft.

On 23 June 2010, the Accident Investigation Board of Finland appointed investigation commission C5/2010L to this occurrence. Investigator Matti Sorsa was named investigator-in-charge, accompanied by investigators Lars Levo and Pertti Kalttonen as members of the commission. The investigator-in-charge invited investigator Erja Savela to assist the commission. The Accident Investigation Board of Finland sent a notification of the incident to the Air Accidents Investigation Branch (AAIB), the European Aviation Safety Agency (EASA) and the International Civil Aviation Organization (ICAO). Pursuant to Annex 13 to the Convention on International Civil Aviation, AAIB appointed an accredited representative of the State of Manufacture, Adrian Burrows, to participate in the investigation.

All times in this investigation report are in Co-ordinated Universal Time (UTC).

The sequence of events was established through the aircraft's DFDR and CVR recordings, ATC radio communications and telephone recordings, and by interviewing relevant parties. Experts at the engine manufacturer's repair station (Honeywell UK Limited, Luton) assisted in establishing the engine damage. Actions of the ATC and airport maintenance unit were examined through interviews as well as from documents and recordings. The investigators observed airport maintenance operations at Helsinki-Vantaa Airport and monitored a runway inspection on site.

Comments on the draft Final Report were requested from the parties involved, Blue1 Ltd, Finavia Corporation, Finnish Transport Safety Agency, Finnish Air Traffic Controllers' Association and the Finnish Pilot's Association as well as from EASA, AAIB and Honeywell. Their comments were received by 2.6.2011. The comments have been taken into account in the investigation report.

The investigation was completed on 16.6.2011.

The material used in the investigation is stored at the Accident Investigation Board of Finland.

1 FACTUAL INFORMATION

1.1 History of the flight

A serious incident occurred on Helsinki-Vantaa Airport runway 22R on Saturday 12 June 2010. An AVRO 146-RJ85 airliner, registered OH-SAR and operated by Blue1 Ltd on flight BLF639, suffered severe engine damage during take-off run. The crew aborted the take-off at 03:47 at the speed of 100 knots, in accordance with applicable instructions. The engine damage generated no fire warning. The aircraft was operating a scheduled flight from Helsinki to Copenhagen. There were 93 passengers and four crew members on board.

After the aircraft had vacated the runway, a runway inspection was carried out at the air traffic control's request. The runway was reported to be free of obstacles, and the controller cleared two transport aircraft for take-off from the same runway. No landings were made on that runway. After this, the pilot-in-command of BLF639 telephoned the air traffic control and told about the severe nature of the engine damage, recommending the runway to be inspected again. For this reason, the controller requested a new runway inspection, which was made by two airport maintenance staff members and two cars. This time, a significant amount of engine pieces was found on the runway. The runway was swept before the next aircraft took off. The crews of the two transport aircraft which took off from runway 22R after the first inspection were informed of the situation through Tallinn ATC.

1.2 Injuries to persons

No injuries to persons. There were 93 passengers and four crew members on board flight BLF639.

1.3 Damage to aircraft

The aircraft outer left engine (engine no. 1) was severely damaged. The turbine section of the engine was destroyed beyond repair. There was no other damage to the aircraft.

1.4 Other damage

There was no other damage.

1.5 Personnel information

Pilot-in-command:	Age 47
Licences	Airline Transport Pilot Licence, valid until 14.12.2011
Medical certificate	JAR Class 1, valid until 16.7.2010
Ratings	All required ratings were valid

Flying experience	Last 24 hours	Last 30 days	Last 90 days	Total hours and landings
All types	8 h 05 min 4 landings	65 h 00 min 53 landings	130 h 50 min 97 landings	6399 h 30 min 5672 landings
Type in question	8 h 05 min 4 landings	63 h 45 min 46 landings	129 h 05 min 90 landings	5500 h 00 min 4989 landings

Co-pilot: Age 29

Licences Commercial Pilot Licence, valid until 23.11.2014

Medical certificate JAR Class 1, valid until 8.11.2010

Ratings All required ratings were valid

Flying experience	Last 24 hours	Last 30 days	Last 90 days	Total hours and landings
All types	4 h 46 min 3 landings	60 h 42 min 23 landings	184 h 14 min 71 landings	3521 h 42 min 1685 landings
Type in question	4 h 46 min 3 landings	60 h 42 min 23 landings	184 h 14 min 71 landings	3059 h 10 min 1152 landings

Tower controller on duty: Age 43

Medical certificate JAR Class 2, valid until 10.05.2011

Ratings All required ATC ratings were valid

The tower controller started working at the control position at 03:09.

Airport maintenance unit staff:

The airport maintenance unit staff members involved in the incident were experienced professional workers and they had a good knowledge of Helsinki-Vantaa Airport.

The shift supervisor at the airport maintenance unit had started a combined duty shift at 19:00 in the previous evening. The shift ended at 11:00, which resulted in an uninterrupted duty time of 16 hours. The airport maintenance worker who made the first runway inspection was working in a normal eight-hour morning shift. The morning shift started at 03:00.

1.6 Aircraft information

Type:	AVRO 146-RJ85
Registration:	OH-SAR, 2085
Certificate of airworthiness:	Valid until 16.4.2011
Serial number and year of manufacture:	E2350, 1999
Maximum take-off weight:	42184 kg
Take-off weight on the incident flight:	39109 kg
Owner:	CityJet Limited
Operator:	Blue1 Ltd
Engine type:	Honeywell LF 507-1F
Engine serial number:	P07794
Engine times:	18432 TSN, 17341 CSN

Figure 1. The aircraft OH-SAR.

Figure 2. The flight deck of the aircraft OH-SAR.

1.7 Meteorological information

Wind was 190 degrees and 9 knots. Visibility was 6 km. Ceiling was 300 feet. According to the ATIS weather broadcast at 03:17, the runway was damp. According to airport maintenance staff observations, the runway was 50% damp with drier areas, as it was getting dry. During the second runway inspection fog was rising, for which reason an inspection for low visibility procedures (LVP) was made at the airport.

1.8 Aids to navigation and radars

Navigational aids and radars had no effect on the incident.

1.9. Communications

Radio and telephone communications had no effect on the incident.

1.10 Aerodrome information

The aerodrome was Helsinki-Vantaa Airport (EFHK). The runway used for take-off was 22R, which is 3060 metres long and 60 metres wide. The aircraft started the take-off run at the end of the runway.

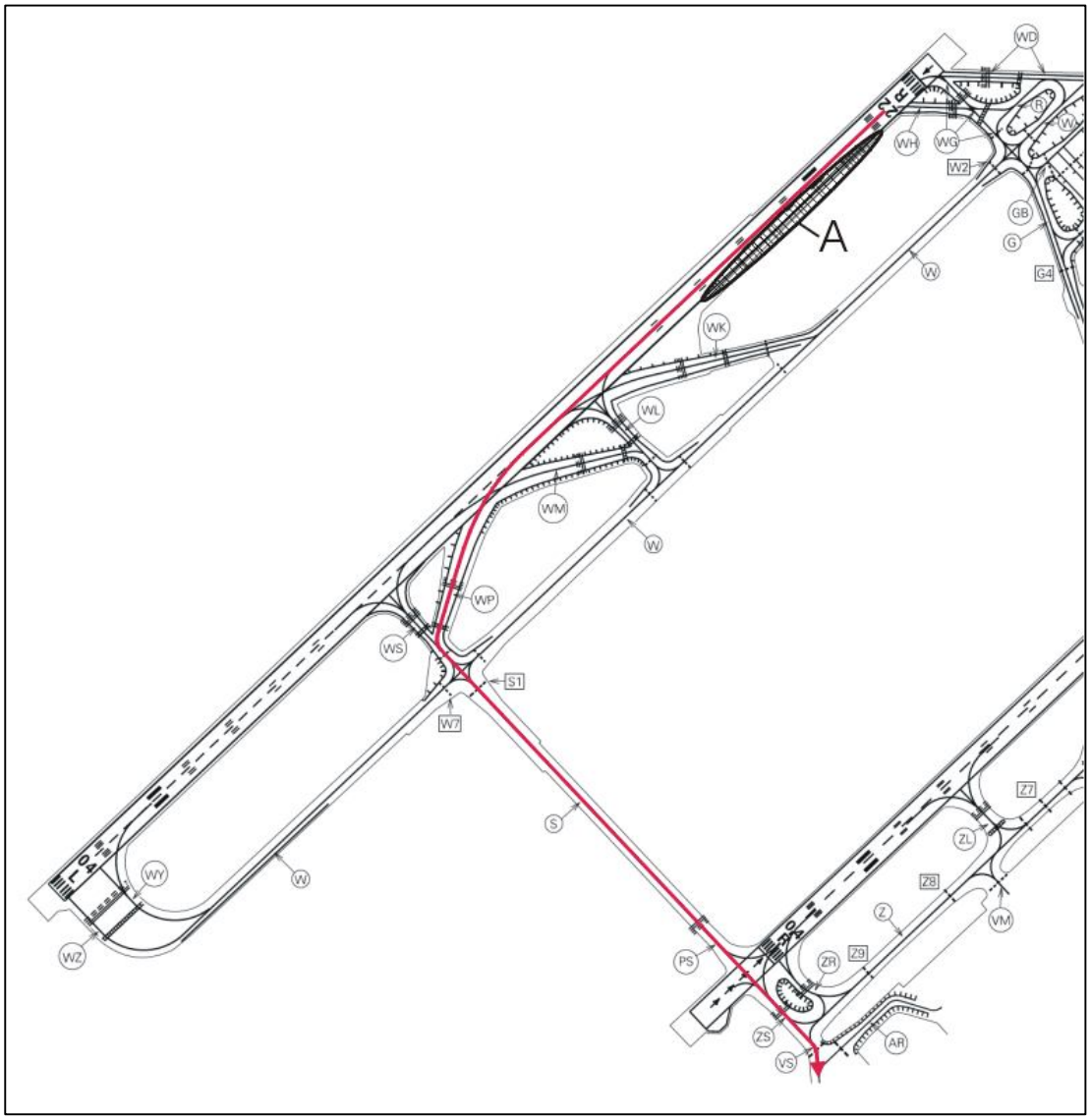

Figure 3. The route of OH-SAR on runway 04L/22R and after, marked with the red line. Most separated engine pieces were found in the area A.

1.11 Flight recorders

The aircraft flight recorders, CVR and DFDR, were sent to be opened and analysed at the UK Air Accidents Investigation Branch (AAIB). The results were obtained from the AAIB on 15 July 2010.

1.12 Runway and aircraft inspection

After flight BLF639 had aborted take-off at 03:47 and exited runway 22R, the flight behind it was cleared for take-off from runway 22L. The tower controller asked the airport maintenance to inspect runway 22R. The pilot-in-command of BLF639 also recommended an inspection when leaving the runway. Besides the runway, the controller requested to inspect the taxiway through which the aircraft had exited. The inspection was

carried out by an aircraft maintenance worker with the vehicle Haukka1. After the inspection, the runway was reported to be free of obstacles at 03:57. The inspection took about three minutes. After this the tower controller cleared two aircraft, FIN1063 (03:59) and BLX361 (04:06), for take-off from runway 22R.

At 04:07, the pilot-in-command of BLF639 informed the aerodrome control tower that pieces were missing from the damaged engine. The tower controller requested a new runway inspection at 04:12. The same vehicle (Haukka1) as earlier was sent for the inspection task, but the airport maintenance shift supervisor joined in the inspection on his own initiative, using another vehicle (Kunto2). Some 50 pieces of the damaged engine, sized 2–40 mm, were found on the runway. First pieces were found about 5 metres left of the runway centerline, while most parts were located about 15 metres left of centerline and some were outside the runway. Longitudinally, the pieces were scattered over a distance of 400 metres. Some pieces had burnt into the runway surface, but could be removed by hand. Since the pieces were very small and of the same colour as the pavement, they could be best detected in a walking inspection. Runway 22R was closed to make sure that it was obstacle-free. The area between intersections WD and WS was thoroughly swept and inspected. In addition, intersection WP, taxiway S and the crossing point of runway 04R were cleaned by sweeping. The sweeping was delayed because of LVP inspections. From the point of view of airport maintenance, the runway was available for traffic again at 07:35.

Figure 4. Pieces of engine found by the airport maintenance unit on runway 22R. The runway surface is shown in the background.

After the tower controller heard that metal had been found on the runway, the controller relayed the information through Tallinn area control centre (ACC) to the two transport aircraft that had taken off from runway 22R between the inspections.

The examination of the damaged engine started at Blue1 Technical Operations with a visual inspection on the day of the incident. The first observation was that there were no signs of a bird strike or other foreign object damage. The compressor area was intact, but the turbine was jammed and could not be moved at all. Chips were found in the bearings. Damage to the engine hot section was extensive.

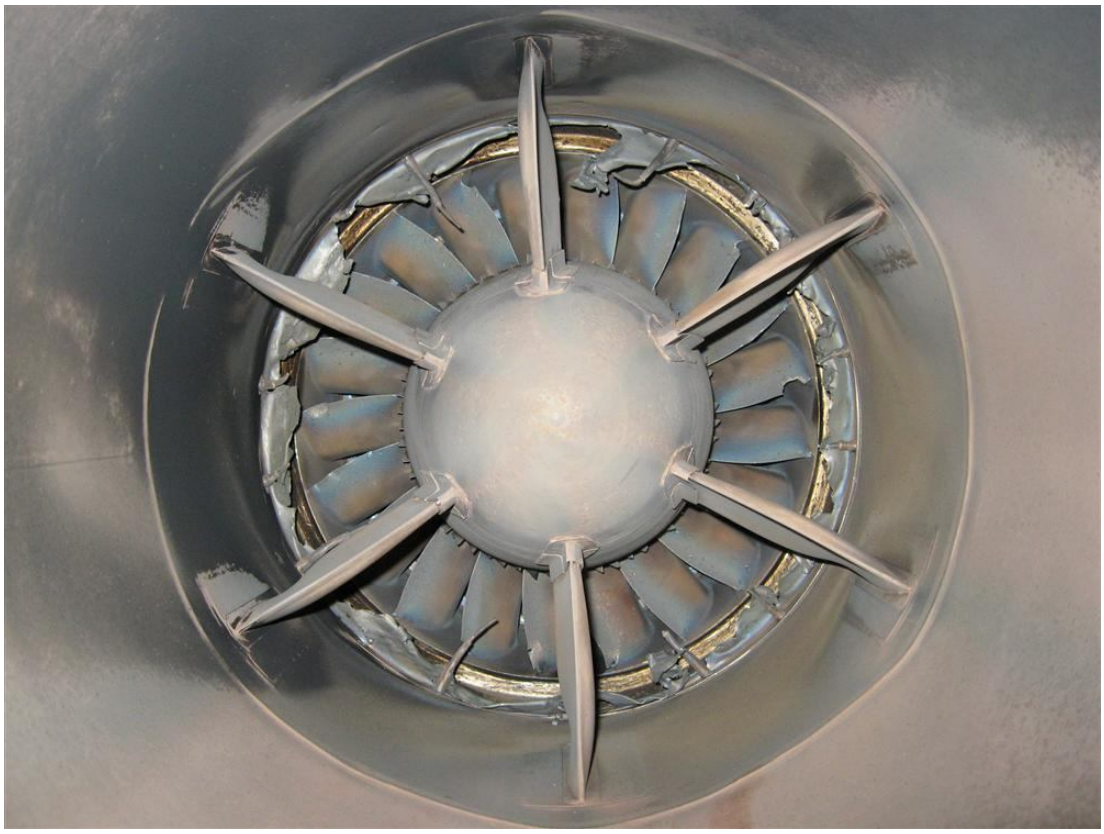

Figure 5. The damaged engine no. 1 pictured from behind after the incident.

Figure 6. The damaged engine no. 1 pictured from the front after the incident.

1.13 Medical information

No medical tests were carried out.

1.14 Fire

There was no fire.

1.15 Rescue operations and survival aspects

Rescue operations were not necessary. When BLF639 aborted the take-off, the tower controller asked if fire and rescue services were needed. The crew replied that there was no need for such services, and no fire vehicles were dispatched.

1.16 Tests and research

The damaged engine was removed from the aircraft and sent to the engine manufacturer's repair station (Honeywell UK, Luton). According to the engine repair report (dated 29 October 2010), the damage originally resulted from a fatigue fracture in the root of a second-stage turbine rotor blade. According to the report that is usually caused by excessive temperature in the turbine during operation or by lack of cooling air in the turbine. However, according to the report no clear signs of blockage in cooling air ducts had been found when the engine was disassembled.

The second-stage turbine blade, which had suffered a fatigue fracture, caused massive overload damage in the third and fourth stage and also damaged bearing no. 4. In the hot section of the engine, a large carbon stain was noted on the combustion chamber liner suggesting the engine had operated with an abnormal fuel manifold spray pattern. The abnormal spray pattern was probably caused by carbon residue in the nozzle.

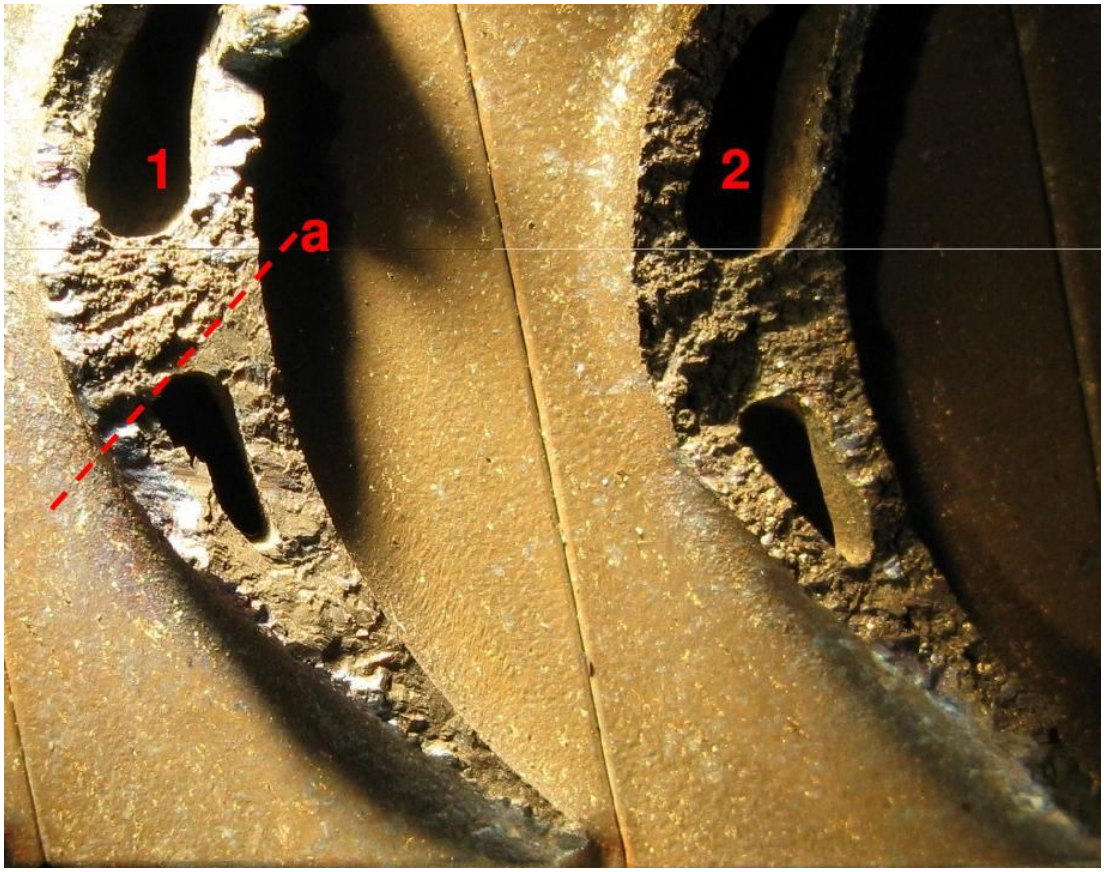

Figure 7. On the left, a turbine blade (1) where the fatigue fracture can be seen as a smoother area up to line (a). Compare with the other blade (2) on the right with an overload fracture surface across the entire root.

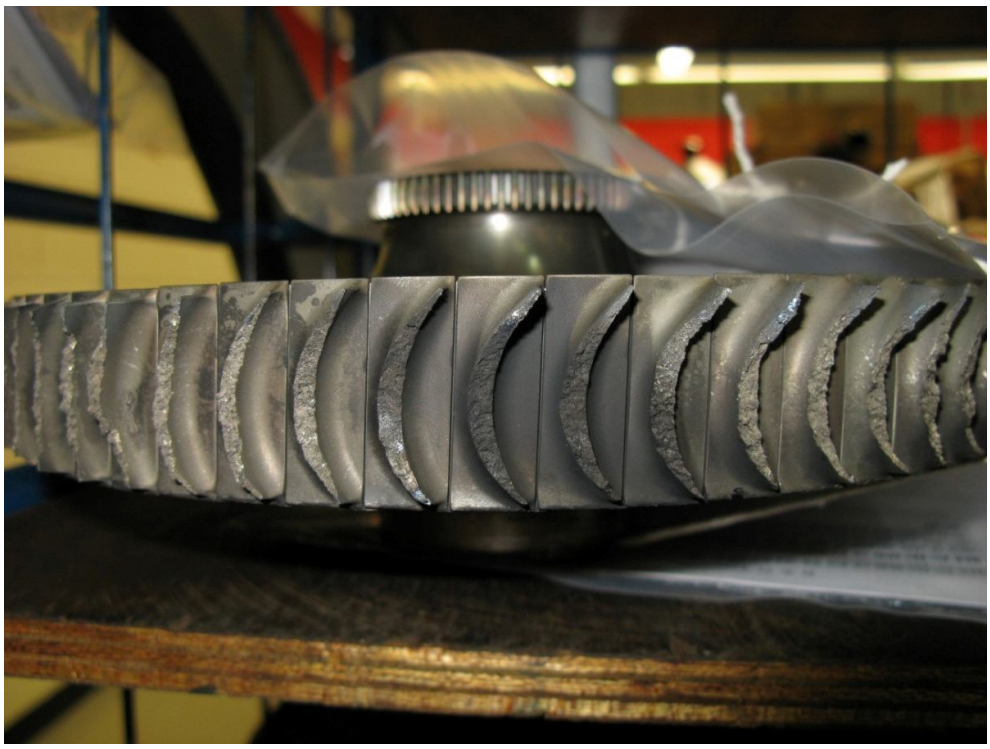

Figure 8. Fracture of all blades caused by overload in the third stage of the turbine.

Figure 9. Damage in the fourth stage of the LP turbine was caused by the detachment of the turbine blades. The LPT4 turbine blade shroud was damaged, and the containment flange was melted but complete. The EGT probes were severely distorted.

1.17 Organisational and management information

The technical organisation structure of Blue1 Ltd as regards engine maintenance is based on the principle that the company only performs line maintenance tasks for the engines. Major overhauls and engine repairs are carried out under a co-operation agreement between Blue1 Ltd and Honeywell International Inc., from which the engines are leased.

The co-operation between ATC and airport maintenance at Helsinki-Vantaa Airport is based on exchange of information at supervisor level, and feedback given through this channel. The tower controllers and airport maintenance operations staff do not meet regularly.

As regards runway inspections, ATC operations are based on the Aerodrome Control section of the Air Traffic Controller's Handbook (LJKK), paragraph 3.4.6: "A runway inspection must be carried out whenever it is suspected that there may be foreign objects on the runway, or when there is uncertainty about the condition of the runway". "When the ATC has been reported or notices something that prevents the safe use of the manoeuvring area, it must notify the unit responsible for the condition of the manoeuvring area and close the relevant section until the responsible unit notifies otherwise". The air traffic controller also has a check list for unusual situations at his/her work station. For aerodrome flight information service (AFIS), the issue is dealt with in Appendix B to the LJKK handbook.

At Helsinki-Vantaa airport maintenance unit, the following instructions, including aviation regulations, are used for runway inspections: Finavia Corporation's airport maintenance instructions (including FOD instructions), EFHK-KK maintenance instructions, EFHK ground traffic instructions and Airside Safety Alert instructions.

After the incident now under investigation, Helsinki-Vantaa airport maintenance unit has drawn up and published a document titled "Runway Inspections", which particularly underlines that the inspections must be made carefully and thoroughly and provides detailed operational guidance. Although the document is unofficial, the staff is required to acknowledge having read it by their signature. The issues contained in the document can also be found in the official airport maintenance instructions.

2 ANALYSIS

2.1 Factors leading to the engine failure

Sensibility to overheat is characteristic to all turbine engines, including Honeywell LF 507-1F, especially if there are excessive air leaks in the engine. According to the engine monitoring report, all engines of the incident aircraft had been running 10–20 °C hotter than the target value at take-off power. However, the temperature values were within acceptable limits. The data in the engine monitoring report is based on observations made between March and July 2010. According to the report, the damaged engine no. 1 was no different from the other engines in this respect. The excessive temperature in the engines had been noticed, and in March 2010 the aircraft had been subjected to a Hot Running Procedure by Flybe Aviation Services Division UK in an engine test run before C maintenance. In this connection, the compressor of the incident engine was washed, some leak tests were made and seals changed.

Methods of use, operating conditions or deficiencies in maintenance did not have an effect on the engine damage, nor was it caused by an external factor such as bird strike. All authority requirements (AD) and manufacturer's service bulletins (SB) had been properly implemented.

By monitoring the engine values, it was not possible to foresee that the engine in question was going to be damaged.

The engines of the operator's Avro aircraft are leased, and their condition monitoring has been outsourced. In the investigation commission's opinion, this had no immediate effect on the incident. However, the investigation revealed that such an arrangement may lead to a situation where responsibility for engine condition monitoring is divided between too many actors, which makes real-time monitoring more difficult. This was shown e.g. in that engine times in service were different in the air carrier's documents and the engine manufacturer's repair station documents. The air carrier's maintenance staff is not necessarily aware of the details of subcontracting agreements.

2.2 Actions in the cockpit after engine failure

On the incident flight, the co-pilot had been assigned as pilot flying (PF) and the pilot-in-command handled the duties of the pilot non-flying (PNF). In accordance with company procedures, the pilot-in-command selected take-off thrust at the co-pilot's command "Takeoff thrust" and pushed the TOGA switch. He then checked the take-off setting from engine instruments and called "Takeoff thrust set". Speed check was made at 80 knots as required.

After this, a noise from outside and the blinking warning lights led to the pilot-in-command's decision to abort the take-off immediately. The take-off was aborted at the speed of 100 knots. This was not a critical abortion, as it occurred clearly before the decision speed (V1) was reached.

In accordance with the company procedures for aborted take-off, the pilot-in-command should call STOP-STOP in a loud voice, which was not done in this case. The procedures do not include reporting the change of control responsibility (e.g. ”My controls”), but it is assumed that the co-pilot as PF understands from the STOP-STOP command that the pilot-in-command will take the controls. Despite leaving out the call-out, the flight crew worked smoothly and in good co-operation. The pilot-in-command’s decision-making was logical and showed excellent control of the situation as a whole. The division of tasks, particularly as regards communications within the aircraft and with the ATC and later with ground services, was well managed.

The airbrake lever was not used during the aborted take-off. The spoilers were deployed automatically. In the aircraft type in question, the spoilers are not manually armed before take-off, for which reason the effect of spoilers in aborted take-off was slightly unclear to the pilots.

The damaged engine generated no fire warning to the pilots, but because of the high temperature indication, the pilot-in-command decided to discharge one bottle of extinguishing agent into the engine. This must be considered as a good precaution.

After the aircraft had arrived at the apron and the passengers had disembarked, the pilot-in-command checked the condition of the damaged engine together with Blue1 Ltd’s technical staff. He decided to report his findings immediately to the ATC, as he saw that, with a high probability, engine pieces remained on the runway. In this way, the runway could be closed without delay and a new inspection carried out. Due to the pilot-in-command’s prompt action, only two aircraft were allowed to take off before the second inspection. The airline technical staff has no agreed procedures for reporting this kind of findings promptly to the ATC. Probably the making of such reports would have been handled in accordance with good airmanship, but there was no established practice in use. The issue is worth noting as the situation is time-critical.

2.3 Actions by ATC and airport maintenance unit

Provisions on airport maintenance unit and its movement area inspections are contained in aviation regulation AGA M3-9 (issued 4.6.2001). At Helsinki-Vantaa Airport, the runways in use are required to be inspected at least three times in each 24-hour period. The inspection must be made to the extent necessary, for example after unusual aircraft movements or when requested by ATC. During the inspection, attention must be paid to foreign objects and contamination in the whole movement area, such as liquid leaks or parts that have fallen out of vehicles or aircraft. The regulation specifies that details about the inspection, the inspected area, time of inspection and the staff member having carried out the inspection must be recorded in the airport maintenance log, or a corresponding report must be made to the ATC by radio so that it will be recorded on the ATC voice recorder.

Paragraph 8.7.1 in Finavia Corporation’s airport maintenance instructions gives guidance on FOD prevention (“Prevention of loose material in the movement area”), and Helsinki-Vantaa Airport has its own complementary instructions (20.3.2003). Finavia

Corporation's maintenance and inspection instructions (6.4.2004) specify how the inspection should be carried out. The instructions correspond with the content of Regulation AGA M3-9 for the necessary parts.

After the incident now under investigation, Helsinki-Vantaa airport maintenance unit published a practical document "Runway Inspections", which is clear and detailed. It underlines thoroughness and accuracy in the inspections, giving detailed instructions on the practical methods of inspection. For example, the document recommends that the inspection should be carried out by two staff members if the conditions are demanding.

In the first request for runway inspection, the air traffic controller expressed the need for an inspection using the normal procedure. The controller did not specify the area to be inspected or state any assumptions on what could be found. In this respect he was strictly following the standard operating procedures. The inspection was carried out by one car and one staff member, which is to be considered a normal method with regard to the request. The inspector drove along the runway with the usual speed and did not focus specifically on any part of the runway.

In the request for the second inspection, the controller specified the area to be inspected and what should be looked for based on the new information received. The task assignment was more specific than for the first inspection. The inspection was carried out by two cars and two staff members, which led to the engine pieces to be found. Much more time was used for the second inspection. Factors contributing to the success of the second inspection were that more accurate information had been received on the nature of the aircraft damage and the probable area where the damage occurred, and that another member of airport maintenance staff joined the inspection on his own initiative.

2.4 Foreign Object Damage

Foreign object damage (FOD) to aircraft is a significant economic burden to airlines. Moreover, it is naturally a very serious potential flight safety threat. The Concorde accident in Paris on 25 July 2000 is a good example on how a relatively small item on the runway may start a sequence of events leading to the whole aircraft being destroyed.

According to statistics[1], about 70 000 FOD incidents occur on world's 300 busiest airports each year. The proportion of serious incidents is approximately 4 per 10 000 take-offs or landings. Of the serious incidents, 3.2 affect the tyres and 0.8 the engines – most typically compressor blades.

On the largest European airports, runways are kept closed due to foreign object hazards for more than 200 minutes per month on an average. According to a study carried out by Delta Airlines, the majority (45%) of FOD objects were from aircraft engines. According to a French study[1], more than 60% of the items were made of metal, and about half of them were dark-coloured and below quarter of an inch in size, as also in the case now under investigation.

[1] Air Transport World (ATW), September 2010

Detecting potentially hazardous foreign objects with technical equipment has only emerged recently[2]. New technology, such as the commercial solutions Tarsier or iFerret, make it possible to inspect the runway several times in an hour, quickly and automatically.

[2] FAA: Advisory Circular on Airport Foreign Object Damage Detection Equipment, 2008; In Europe: SESAR ATM Master Plan – Automatic FOD Detection Technology, 2008

3 CONCLUSIONS

3.1 Findings

1. The aircraft certificate of airworthiness and registration certificate were valid.

2. The flight crew licences and ratings were valid.

3. The air traffic controller's licence and required ratings were valid.

4. The airport maintenance unit staff members involved in the incident were experienced workers at Helsinki-Vantaa Airport.

5. The effect of weather factors on the sequence of events was limited to damp conditions on the runway, which made the engine pieces difficult to detect.

6. The flight was a scheduled passenger flight.

7. The take-off was aborted without delay because of severe damage to engine no. 1.

8. The first runway inspection was requested and carried out in accordance with normal routine procedures. The objects on the runway were not detected, and the runway was incorrectly reported to be free of obstacles.

9. Two transport aircraft were cleared for take-off from the runway, which had been reported to be free of obstacles.

10. The runway was inspected again after the immediate findings from an engine inspection on the apron had been reported to the ATC.

11. The airport maintenance shift supervisor joined the second inspection on his own initiative, and the controller specified the area and objects to be inspected according to the new information he had received. Several engine pieces were found on the runway.

12. The pilots-in-command of the transport aircraft which had taken off between the runway inspections were informed of the findings on the runway.

13. The air carrier's (Blue1) instructions on pilot actions in the event of aborted take-off were found to be appropriate.

14. In a later inspection, it was concluded that the engine damage had resulted from a fracture in the root of a second-stage turbine rotor blade.

15. The rotor blade fracture was probably caused by overheat in the engine although other causes could not be excluded. The fracture could not be predicted on the basis of current engine condition monitoring procedures, which showed no difference between the damaged engine and the other engines.

16. Engine maintenance actions had been signed as having been performed properly and on time, without exceeding any service life limitations.

17. The pilots, ATC and airport maintenance unit filed reports on the incident in accordance with applicable regulations.

18. The investigation commission classified the incident as a serious incident, because two transport aircraft took off from a runway which should have been closed as unfit for movement of aircraft.

3.2 Probable causes and contributing factors

A serious incident developed because two transport aircraft were cleared for take-off while there were engine pieces on the runway, which could have damaged the aircraft during take-off run. The engine pieces remained on the runway, since they were not found in the first runway inspection carried out after the aborted take-off.

The first runway inspection failed partly because any detailed assessment about the nature and location of the incident was not given in conjunction with the inspection request, and the airport maintenance unit therefore did not see any specific reason to inspect the runway more thoroughly than usual. The ATC actions when asking for runway inspection and providing related information to the airport maintenance unit were in accordance with the instructions and established practices at the aerodrome.

4 SAFETY RECOMMENDATIONS

4.1 Measures implemented

During the investigation, an unofficial document titled “Runway Inspections” was distributed to the staff at Helsinki-Vantaa airport maintenance unit. The document underlines that the inspections must be made carefully and thoroughly, and that the runway must not be reported to be free of obstacles unless there is certainty about that.

4.2 Safety recommendations

1. As the current instructions concerning runway inspections and co-operation between units at Helsinki-Vantaa Airport does not specify what information should be given to other units with an inspection request,

   the investigation commission recommends the Finnish airport operator Finavia Corporation to make the instructions for runway inspections more specific, so that the inspecting staff would have all available necessary information about the situation at their disposal during the inspection.

2. As the investigation revealed that the technical staff of air carriers operating in Finland usually have no instructions for situations where aircraft parts may remain on the runway and the ATC should be informed about that without delay,

   the investigation commission recommends the Aviation Sector of the Finnish Transport Safety Agency (Trafi) to examine the current status of instructions and oversee that any deficiencies are rectified.

3. As Foreign Object Damage (FOD) to aircraft is a significant flight safety threat and new technology exists to manage the risks associated with it,

   the investigation commission recommends Finavia Corporation to find out whether foreign object detection technology suitable for the local conditions is available and, based on studies, decide on the necessity of obtaining such equipment.

4.3 Other remarks and proposals

Since the effectiveness of co-operation between ATC and airport maintenance unit largely depends on communication practices and the investigation has revealed that, at least at Helsinki-Vantaa Airport, regular exchange of information is mainly focused on supervisor and senior staff level, the investigation commission suggests that Finavia Corporation increase regular and continuous co-operation between ATC and airport maintenance operations staff at all of its airports.

Helsinki 16.6.2011

Matti Sorsa

Lars Levo

Pertti Kalttonen

Appendix 1

AAIB's comments

Berkshire Copse Road
Aldershot
Hants GU11 2HH
United Kingdom

Tel:- 01252 510300
Telex:- 858119 ACCINV G
Fax:- 01252 376999

Air Accidents Investigation Branch

Department for Transport

Marcus Bergman
Chief Air Accident Investigator
Onnettomuustutkintakeskus
Sörnäisten rantatie 33 C
FIN-005500 Helsinki
FINLAND

Our Ref EW/B2010/06/01
Your Ref C5/2010L
Date 04 May 2011

Dear Mr Bergman:

Serious Incident to AVRO 145-RJ85, OH-SAR, at Helsinki-Vantaa Airport on 2 June 2010

Thank you very much for offering the AAIB the opportunity to comment on the draft investigation report on the above accident. We acknowledge that the report is an English translation of the original Finnish report and it is on that basis that it has been reviewed. To assist us in the review, we asked the aircraft manufacturer, BAE Systems, for comments, of which there was one:

(1) In Paragraph 2.2, it was noted that during the rejected take-off (RTO), the crew did not perform the RTO in accordance with the recommended manufacturer's procedures (see attached). In this instance the spoilers deployed, but not the airbrake, due to the auto-spoiler operation. The RTO procedure, however, requires:

AIRBRAKE lever …… Select LIFT SPLR, confirm deployed.

We think that this should be acknowledged in the report.

BAE Systems also suggested that the engine Type Certificate holder (Honeywell) might wish to comment on the engine aspects detailed in the report if they haven't already been asked to do so. (The recommended point of contact at Honeywell in the USA is David Studtmann – david.studtmann@honeywell.com – (602) 3652414.)

Yours faithfully

ADRIAN BURROWS
Senior Inspector of Air Accident

Appendix 1

Rejected Take-off

Thrust levers	IDLE
Wheelbrakes	Apply maximum braking
AIRBRAKE lever	Select LIFT SPLR, confirm deployed.
Aircraft	Stop - turning into wind in case of fire
Parking brake	On
PA announcement	Alert cabin crew

Evacuate or not - decide

If not evacuating:

BRAKE FANS	ON
Taxiing	Minimise

When stopped:

Nose wheels	Chocked
Parking brake	OFF

Do not approach within 25 m of the side of the wheels until the brakes have cooled below 450°C.

Emergency Evacuation

Captain

Aircraft	Stop
Wheelbrakes	PARK
Thrust Levers	FUEL OFF
PA	Order evacuation

First Officer

OUTFLOW VALVES	DUMP
APU	STOP
APU FIRE EXT	DISCH
FIRE HANDLES	Pull to full extent Rotate to EXT 1 and 2
ATC	Call on VHF 1
Battery power	Leave ON

Leave the Aircraft