RAPORT I HETIMIT TË AVIONIT ZKM KHAIA 004/R

Republika e Kosovës
Republika Kosova-Republic of Kosovo
Qeveria –Vlada-Government
Zyra e Kryeministrit – Ured Premijera –Office of the Prime Minister

Komisioni për Hetimin e Aksidenteve dhe Incidenteve Aeronautike /Vazduhoplovna Komisija za Istraživanje Nesreća i Incidenata/Aeronautical Accidents and Incidents Investigation Commission

Raport mbi Aksidentin e ndodhur në Aeroportin e Prishtinës "Adem Jashari" më 12 maj 2015, ku është përfshirë Helikopteri Aerospatiale Puma SA330 J me regjistrim EI-SAI, i operuar nga Starlight Aviation

Report on Accident that Occurred at Airport of Pristina "Adem Jashari" on 12 May 2015, involving a Helicopter Aerospatiale Puma SA330 J with registration EI-SAI, operated by Starlight Aviation

Izveštaj o nezgodi koji se dogodio 12 Maj 2015. godine na aerodromu Priština „Adem Jashari“, gde je uključeno helikopter Aerospatiale Puma SA330 J sa registracijom EI-SAI, kojim upravlja Starlight Aviation

PRISHTINË 2019
PRISTINA 2019
PRIŠTINA 2019

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ENGLISH LANGUAGE VERSION

PRISTINA: 2019

Aeronautical Accident and Incident Investigation Commission is established on the basis of the Law No. 03/L- 051 on Civil Aviation of Republic of Kosovo. The Commission shall be responsible to investigate aviation accidents and incidents within Kosovo territory or which involve airplanes registered in Kosovo, wherever they may be. According to regulation (AAIIC/OPM) NO.01/2017 on the investigation and prevention of accidents and incidents in civil aviation and to international Aviation regulations, more precisely to Annex 13 of The Convention of International Civil Aviation, if the accidents or incidents nevertheless occur, a thorough investigation into the cause of the problem, irrespective of who is to blame for it, may help to prevent similar problems from occurring in the future. It is important to ensure that the investigation is carried independently and in full coordination between the parties involved. The Commission shall be authorized to ask from any public authority of Kosovo and natural person or organization in Kosovo to provide the required support to them for the performance of a certain investigation as defined by the Law on Civil Aviation or an investigation deriving from an international agreement or by an international aviation organization.

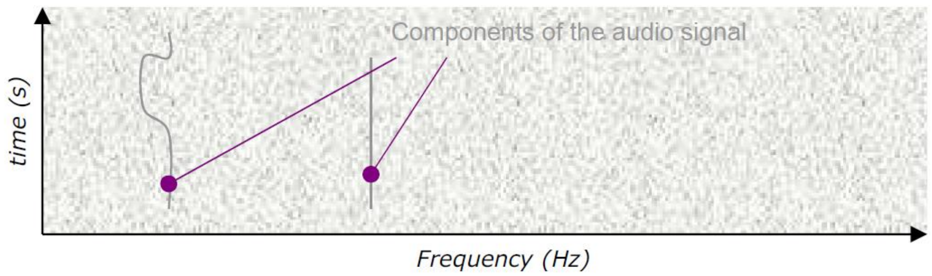
If there are discrepancies between language versions, priority will be given to the **ENGLISH LANGUAGE VERSION** in accordance with international rules on aviation safety investigation, more precisely to Annex 13 of The Convention of International Civil Aviation

Contents

GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AAIIC	Aeronautical Accident and Incident Investigations Commission
AGL	A height above ground level
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
BEA	Le Bureau d'Enquêtes et d'Analyses (French authority responsible for safety investigations into accidents or incidents in civil aviation)
CAA	Civil Aviation Authority
CAM	Cockpit Area Microphone
CMM	Component Maintenance Manual
CO	Co-pilot
CPL (A)	Commercial Pilot's License
CRM	Crew resource management
CVR	Cockpit Data Recorder
°F	Fahrenheit (1 ° F equal to -17.2222 ° C)FDR Flight Data Recorder
FH	flight hours
ft	feet
h	hours
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
IGB	Intermediate Gear Box
kg	kilogramme
L/H or LH	Left Hand
LDP	Landing Decision Point
m	meter
MCP	Mode Control Panel
METAR	Meteorological Aviation Weather Report
MGB	Main Gear Box
NM	nautical mile
NR	Main rotor speed in Rpm **Value at 100% = 265 Rpm**
ºC	Degrees Celcius
PF	Pilot Flying
PIA	Pristina International Airport "Adem Jashari"

PIC	Pilot in Command
PM	Pilot Monitoring
Propulsion system	Engines, bear boxes and rotors assembly
QNH	Pressure setting to indicate elevation above mean sea level
R/H or RH	Right Hand
R/H or RH	Right Hand
RA	Radio Altimeter
Rpm	Revolution per minute
TGB	Tail Gear Box
UTC	Co-ordinated Universal Time (the contemporary equivalent of GMT)
V/S	Vertical Speed
Spectrum View	(LOFAR) spectrum view / frequency on X-axis and time on Y-axis



Aeronautical Accidents and Incidents Investigation Commission

Investigation Report No:	**ZKM KHAIA 004/ R**
Type of Occurrence:	Accident
Date:	12 May 2015
Location:	Pristina International Airport Adem Jashari
Aircraft:	Rotary Wing Puma SA330 J Helicopter
Manufacturer / Model:	Airbus Helicopters / Serial no:1545
Registration:	EI-SAI
Injuries to Persons:	2 Minor injuries to rear crew
Damage:	Damaged beyond economic repair
Other Damage:	Impact damage to runway surface

1. Factual Information

On 12 May 2015, at 15:04[1]h the helicopter was on a training flight and the Flight Crew were simulating an engine failure on approach, after the “Landing Decision Point (LDP)”. After a firm touchdown the helicopter bounced and when it touched down again it veered to the left, and tipped over on its right side causing substantial damage to the helicopter. The two Flight Crew members onboard were uninjured, however the two medical crew passengers in the cabin sustained minor injuries. There was no fire.

1.1 History of the Flight

The Flight Crew had conducted a pre-flight briefing concerning the training exercise that was going to be conducted, including engine failure simulation below LDP.

At 14:22 h, on 12 May 2015, the helicopter, registration EI-SAI, reported to the Controller of Pristina Airport that it was ready to depart from the Eulex Helipad and requested start for a training flight (touch-and-go) at Pristina International Airport. On board the helicopter were two flight crew members and two medical crew passengers. The Pilot in Command (PIC), a training captain, was Pilot Monitoring (PM) and the Co-pilot was a trainee, and Pilot Flying (PF). The exercise was being conducted on Runway (RWY) 35, and the PF was scheduled, amongst other things, to perform a simulated engine failure after the LDP.

According to the tower recordings, at 14:24 h, Air Traffic Control (ATC) informed the helicopter that in the following 30 minutes, there would be three or four arrivals on the runway. At 14:33 h, the helicopter reported to the Controller that it was ready to depart from the Eulex Helipad and requested a left-hand circuit for RWY 35 to conduct a touch and go, and thereafter to proceed toward the east of the airfield to join downwind. The Controller told the helicopter to stand by in order to attend to other traffic. After this, the Controller cleared an IFR military aircraft to land on RWY 35.

The Controller then contacted the helicopter, cleared it for take-off at its own discretion, and requested it to report when it was on a left downwind for RWY 35. Just prior to take-off, ATC informed the helicopter of an item of IFR military traffic that was on short finals for RWY 35, and to report it in sight. During the downwind leg, the

[1] All times in the Report are in Local Time, unless otherwise stated.

helicopter reported that he had the military traffic in sight on the runway. ATC then cleared the helicopter for the approach to RWY 35, to report on finals, and that there was another item of traffic at 13 NM finals for RWY 35. As the helicopter was performing its first touch-and-go on RWY 35 the item of jet traffic reported at 3.5 NM. ATC requested the helicopter to expedite its take-off from the runway. After landing, the jet traffic informed ATC that it appeared that the separation between it and the helicopter was not sufficient, and that they would be filing a report[2].

The helicopter then commenced a right circuit for RWY 35, and at 14:59 h, the helicopter reported to the Controller that it was turning right base for a touch- and-go '*mid-runway*'. The Controller cleared the helicopter for a touch-and-go on RWY 35, and reported the wind as 350 degrees and 6 knots.

At approximately 100ft AGL, as briefed prior to flight, the instructor PM called that he was 'cutting' the engine, and reduced the power on engine number one to idle, in order to simulate an engine failure.

The helicopter made a firm touchdown at the beginning of the runway, followed by a bounce. When it touched down again it veered left and tipped over on its right side during which the right main landing gear collapsed. The helicopter sustained substantial damage.

ATC alerted the emergency services, which responded immediately.

The Flight Crew and medical passengers evacuated the aircraft. There was no fire.

1.1.1 Pilot interviews

The Investigation carried out interviews with the Flight Crew on the day following the accident (13 May 2015). The PIC was later interviewed by the AAIU (5 August 2015). Both Flight Crew members also submitted statements of their recollection of the accident. The Flight Crew members both indicated to the Investigation, that they were of the opinion that there was no mechanical or technical issue with the helicopter that might have contributed to the accident.

[2] This became the subject of investigations by the Kosovo CAA, and the ATC unit at Pristina.

The Interview received statements from the two medical crew passengers HEMS[3] seated in the rear of the Helicopter at the time of the accident.

1.1.1.1 Pilot in Command (PIC)

The PIC stated he was a training captain and pilot monitoring (PM). He informed the Investigation that the flight was a 'recurrent training flight'. He had briefed the Co-pilot prior to the flight, and discussed the fact that they would be carrying out One Engine Inoperative (OEI) training, including an engine failure after LDP. The Flight Crew had discussed the various decision heights that would be required for the meteorological conditions that were expected, and the PIC confirmed to the Investigation that for the 'engine failure after LDP', the LDP was defined as 100 ft AGL and 40 kts. He also stated that it was normal practice to announce prior to the exercise, what the exercise would be, what was expected, and that there would be 'no surprises'.

The PIC stated that the first few circuits onto the active runway (RWY 35) at BKPR, were normal, although during one landing, there was a report of a loss of separation between their helicopter and an inbound commercial jet aircraft. He told the Investigation that there was no perceived or actual pressure put on the Flight Crew due to this report.

The PIC stated that during the accident circuit, the flight proceeded normally and that he informed the Co-pilot that on the approach he would call 'engine failure' and retard the number one engine to idle to simulate the failure, and that the failure would occur below LDP. He said he retarded the number one engine to idle at approximately 80 ft.

The PICinformed the Investigation that it appeared that the Co-pilot, who was PF, may have '*flared a little too much on that point* [and the] *helicopter came to an almost stop with an increasing rate of descent. To cushion the touchdown I assisted the PF by pulling full collective and decreasing the main rotor NR*'. *The impact was firm with the correct attitude to avoid a tail strike followed by a bounce up to about 3 feet.* The PIC noted that during the bounce there was a '*left turning tendency of the helicopter. To avoid* [becoming] *airborne again and to enter a not controllable situation I lowered the collective gently to get the helicopter finally to the ground. We touched the ground*

[3] HEMS: Helicopter Emergency Medical Service

still turning left. The movement was not controllable by tilting the rotor- disk as we ended up in a dynamic rollover'.

The PIC also stated that '*When the first blades touched the ground we shut off both engines by the fuel shutoff lever. Thereafter, we evacuated the cockpit via the left pilot door. Outside the helicopter we* [became] *aware that the left sliding door was open and expected the medical crewmembers to disembark. As I felt it took too long, I climbed on the fuselage to have a look into the cabin.* The PIC said he talked to the HEMS passengers, telling them they should evacuate immediately, and '*they left the helicopter thereafter without any delay'.* The PIC informed the Investigation that the Flight Crew and HEMS passengers gathered at a safe distance from the helicopter and awaited the arrival of the emergency services.

1.1.1.2 Co-pilot

Co-pilot stated he was a trainee, and was the Pilot Flying (PF) during the accident flight. He also informed the Investigation that there was a briefing before the training flight, and that there would be a simulated engine failure on approach below LDP. This would be done by reducing one engine to idle.

The Co-pilot told the Investigation that on approximately the 6th circuit '*it was planned and briefed that the engine would be cut* [brought back to idle] *at below the decision point* […] *so we had discussed and brief before that if the engine cuts, or when it cuts, below 100 ft* […] *we would land* […] *So at 80 ft the engine was cut* [by the] *Commander* […] *he warned me the engine was going to be cut* […] *We commenced toward the ground and at about 20 ft, it is difficult to describe exactly, because things happened so fast… and about 20 ft I initiated the correct procedure… I commenced recovery procedure after which the NR (speed at the blades) started decaying* [blade RPM reducing]. *At that point the helicopter hit the ground in a level altitude.*

The Co-pilot stated that the helicopter made a firm, positive touchdown, and would not have described it as a hard landing. He said the helicopter then bounced to approximately 3 ft. The Co-pilot informed the Investigation that the helicopter then touched down again, with a slight nose-down attitude after which the collective pitch was lowered to increase the NR. The Co-pilot noted that at that point the helicopter '*started veering or moving slightly to the left…it started rolling on the wheels, but it got hooked on the undercarriage'*

The Co-pilot said that shortly after this the helicopter started to topple over and turned left a further 120°, and came to rest on its right side very close to the centerline of RWY 35. The two pilots shut off the engines and exited the cockpit via the left cockpit door. The Co-pilot said the Commander went back to the helicopter to tell the HEMS passengers to evacuate.

The Co-pilot noted that one of the HEMS medical crew appeared to have some pain in his left lower abdomen or chest area. The HEMS Doctor attended to him, and they awaited the assistance of the Airport authorities.

1.2 Personnel Information

1.2.1 Pilot in Command (PIC)

The PIC was Pilot Monitoring (PM) also the training captain. He stated that prior to flying helicopters, he had acquired significant flight time on commercial fixed-wing jet aircraft, with a total of 18,500 hours on fixed-wing. The table below reflects the PICs helicopter flying experience.

Pilot in Command Experience:	5624 hours in total
	3369 hours as training captain

1.2.2 Co-pilot

The Co-pilot was Pilot Flying (PF) and also a trainee.

Co-pilot Experience:	7271.1 hours in total
	791.6 hours in type

1.2.3 HEMS Crew

There were two medical personnel on board during the flight exercise.

1.3 Aircraft Information

Manufacturer:	Airbus Helicopters
Type:	Puma SA330 J
Year of manufacture:	1978
Serial number:	1545
Maximum Take-Off Mass:	7,400 kg
Actual weight at time of occurrence:	6,087 kg
Engines:	2 x Turbomeca Turmo IV-C

After the accident, the aircraft was guarded by airport security until an investigation of the wreckage was commenced by the IIC of AAIIC. The investigation was also assisted by ACCREPs from the French Le Bureau d'Enquêtes et d'Analyses (BEA) and the Irish Air Accident Investigation Unit (AAIU). Technical assistance was provided by representatives of the Operator, under the supervision of the IIC.

The internal configuration of the Helicopter was as below: Image 1.

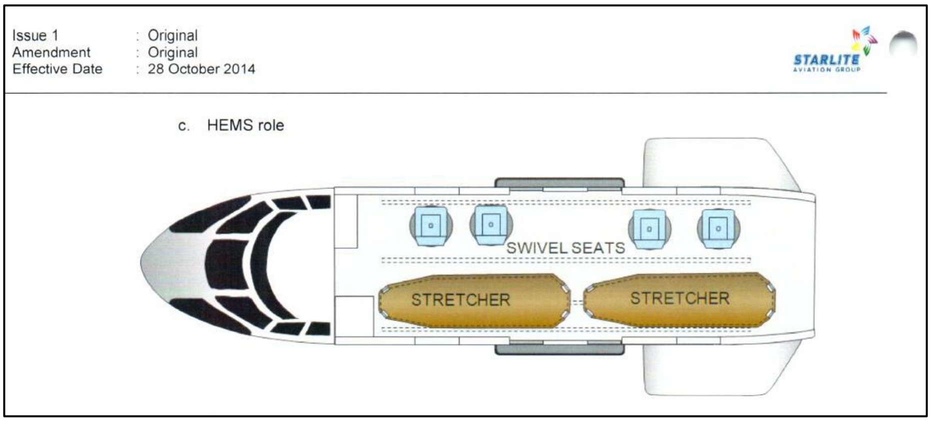


Image 1: Internal configuration Source: operator

1.3.1 Maintenance Information

The Helicopter maintenance records were provided by the Operator. Examination of the maintenance records did not show any pre-existing defects that may have contributed to the accident.

1.3.2 Weight and Balance

The helicopter weight and balance information was provided by the Operator. Based on the actual Loadsheet of 12 May 2015, all values were found to be within the allowed limitation envelope.

1.4 Meteorological Information

Pristina International Airport "Adem Jashari" (BKPR) weather observation at 13:00 UTC: wind from 350° at 8 kts, visibility at 9999 m, rain, clouds were Scattered at 4,000 feet, temperature 21°C, dew point 5°C, altimeter 1 024 hPa. No significant change. The following weather shows the overall weather situation at Pristina International Airport "Adem Jashari".

Archived METAR from 12 May 2015 in the period of 11:00 to 14:30 UTC:

METAR/SPECI from BKPR, Pristina (Kosovo).

METAR BKPR 121430Z 35011KT 9999 FEW040 BKN070 21/06 Q1024 NOSIG=

BKPR 121400Z 36009KT 9999 FEW040 SCT060 21/04 Q1024 NOSIG=

METAR BKPR 121330Z 02008KT 9999 SCT040 20/03 Q1024 NOSIG=

BKPR 121300Z 35008KT 9999 SCT040 21/05 Q1024 NOSIG=

METAR BKPR 121230Z 02005KT 9999 FEW040 SCT060 20/04 Q1025 NOSIG=

BKPR 121200Z 01007KT 340V050 9999 FEW040 SCT060 20/05 Q1025 NOSIG=

METAR BKPR 121130Z 04007KT 360V100 9999 SCT050 19/04 Q1025 NOSIG=

BKPR 121100Z 07007KT 020V110 9999 SCT050 20/05 Q1025 NOSIG=

1.5 Aids to Navigation

Not applicable, as the helicopter was operating under VFR.

1.6 Communications

Communications between the helicopter and ATC in Pristina were conducted in English. A transcript was provided by Pristina ATC.

1.7 Aerodrome Information

Pristina International Airport "Adem Jashari" (BKPR) is located 15 km south-west of Pristina city and 3 km south of Slatina. The airport has one runway with the orientation 176°/356°.

Runway designator: 17 / 35

Runway dimension:	2 500 m x 45 m
Runway surface:	Asphalt
Aerodrome reference code:	4C

1.8 Flight Recorders

The helicopter was equipped with a Cockpit Voice Recorder (CVR). There were no legal requirements for this type of helicopter to be equipped with Flight Data Recorder (FDR), hence no FDR was installed.

The CVR was located in the rear part of the helicopter airframe and was removed from the helicopter by the Operator's engineers in the presence of the AAIIC investigators. The CVR was found to be in a good condition.

The helicopter was fitted with a Monitair unit. This is a computer, similar to a helicopter HUMS[4] unit, designed to record engine and helicopter parameters for maintenance purposes. Data is stored into a volatile memory. Flight reports and associated failure messages are also recorded.

1.8.1 CVR

Manufacturer:	Fairchild A100A
Type:	SSFDR
Serial number:	52061
Part Number:	93-A100-11

The recorder had no visible damage. CVR download took place at the BEA in France on 26 May 2015.

WORK PERFORMED

[4] HUMS: Health and Usage Monitoring System.

The CVR (Image 2) was found in external good condition.

Image 2: Cockpit Voice Recorder Source: BEA/FRANCE

Direct readout

The CVR was connected and powered on the manufacturer bench (LORAL-Fairchild CVR panel P/N: 9300A860-01) to perform a preliminary download of the mixed 4 audio channels data.

Note: The A100 CVR type records about 31 minutes of audio data on an endless-loop magnetic tape device.

Note on the BEA readout bench:

The A860 CVR panel is used to power the CVR. Once powered, the CVR automatically runs the tape mechanism. Both the ‘Erase’ and/or the ‘Record’ function are disabled during the direct readout process performed at BEA. A ‘Read’ magnetic head integrated into the tape mechanism reads the mix of the 4 audio channels data. Thus a single audio signal is delivered by the *A860 panel.*

The direct readout of the CVR unit of the event (S/N 52061) failed. No audio signal was delivered. The IIC, following BEA investigators proposal and with the operator agreement, agreed to open the unit in order to perform the magnetic tape extraction.

CVR opening – Tape retrieval

The CVR was opened using the manufacturer and BEA procedures (Image 3)

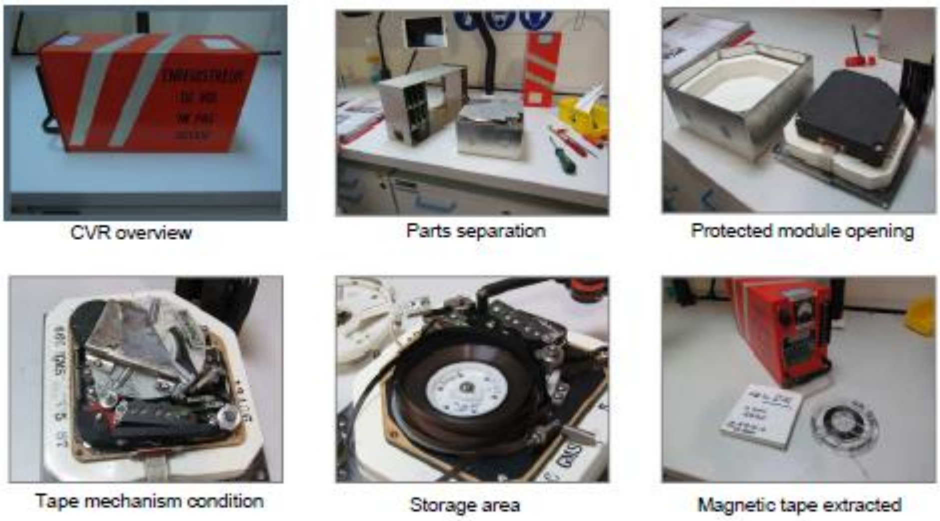


Image 3: Opening of Cockpit Voice Recorder Source: BEA/FRANCE

The tape was successfully extracted from the protected module. However, the tape was found severally folded at the location of the motor drive capstan and in a mess in the storage area.

Tape replay – Audio data retrieval

The tape was placed on the BEA laboratory magnetic tape player equipped with a specific A100 type recorder's head. The readout provided 4 audio signals. Audio channels were acquired to generate the audio project.

Audio preliminary analysis

A multi-track audio project was created. The duration of the recovered recording from the recorder was 30 min 40 s. The 4 channels (Image 4) are described on the Samplitude® project view below (identification of tracks is based on the CVR's CMM):

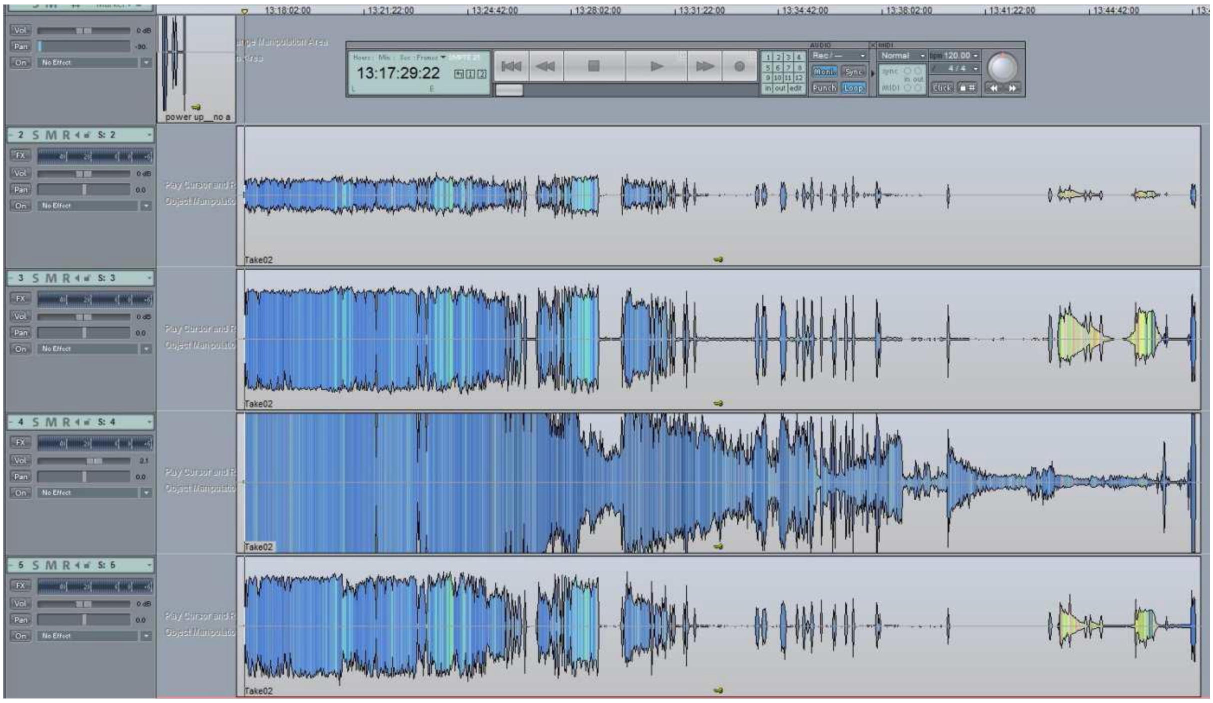


Image 4: Identification of tracks is based on the CVR's CMM Source: BEA/FRANC

The 4 audio signals were found to be in bad quality. No audio data consistent with a flight phase (take-off, cruise, landing, …) was found.

Some ATC messages were however recorded on the tape and the CVR recording was synchronized thanks to UTC time reported on the ATC report provided by the IIC ("*Transcript of communication on Pristina frequency 120.125*" / from 11:46:09 to 13:24:18 UTC time).

The CVR recording started at 13 h 17 min 29 s, ATC time. The CVR unit stopped recording at 13 h 48 min 00 s, ATC time. The accident was reported to have occurred at 13 h 02 min 00 s, ATC time, which was not within the mentioned time interval.

RESULTS OF THE CVR READOUT

The CVR recording did not contain any information related the landing and roll-over phase.

The CVR was most probably still powered-up after the accident and kept on recording data. Thus all the data relative the landing phase was overwritten.

1.8.2 Monitair

The Monitair (Image 5) is a computer designed to record engine and helicopter parameters for maintenance purposes. Data is stored into a volatile memory. Flight reports and associated failure messages are also recorded.

Monitair
ECT industries
P/N : REC-VE5-06
S/N : 591

Image 5: Monitair Source: BEA/FRANC

Work performed:

The Monitair was found in good condition. The computer was opened and the battery that allows the data retention was measured at 7,5 V. According to the manufacturer, even if the value was sufficient to maintain the data, the battery should be recharged. The Monitair was then connected to an external power supply. An internal relay was found to be continuously shuttling. The manufacturer indicated the recharge should be stopped, and the data download in its facilities.

The computer was powered up on the manufacturer’s test bench in accordance with the their procedures. All the recorded data were directly displayed on the computer screen and were photographed. Listings of parameters and flight reports with the last associated failure messages were generated.

The Operator informed the Investigation that they did not use the Monitair unit.

Monitair Download Results:

The last recorded parameters and flight report were dated from the 10/02/2015. Engine and helicopter parameters were recorded between the 28/01/2015 and the 10/02/2015. Flight reports were recorded between the 23/04/2014 and the 10/02/2015.

Some failure messages were associated with the last recording on the 10/02/2015:

- volatile memory full
- torque meter fault
- compensation sensor fault
- skid switch fault

Similar failure messages were recorded during the previous flights, and especially a « volatile memory nearly full » message.
Last maintenance was performed on 27/02/2013 on the computer. The next one was scheduled on 2016.

Conclusion:

No data associated to the accident flight was recorded.

1.8.3 ATM data examination / spectrum analysis

Circumstances and objectives of the examination:

The helicopter rolled over soon after a hard landing during a training flight. The event reported time was 13 h 03 min 00, ATC time. The BEA Laboratory conducted a spectrum analysis of some communications coming from the EI-SAI helicopter recorded on the ATC recordings.

Data provided	ATC recording Files	
Recording 1	*120.125 MHz 12052015 — 8 00 to 11 00*	88 audio files (.wav) / from N°1 to 88
Recording 2	*120.125MHz 12052015 — 12 00 to 14 00*	50 audio files (.wav) / from N°1 to 50

WORK PERFORMED

Audio sample analysed

In the scope of the investigation only the last messages emitted by the helicopter were analysed. They were all part of the Recording 2 data set (*120.125MHz 12052015 __ 1200 to 14 00)*.

From 12 h 48 min 00 to 13 h 05 min 00, eight messages from EI-SAI were recorded. See details below:

Audio sample content:

- "28.wav" / 2 messages (at 12h48m13 and 12h48m36)
- "32.wav" / 2 messages (at 12h53m36 and 12h53m49)
- "33.wav" / 1 message (at 12h54m04)
- "36.wav" / 1 message (at 12h56m21)
- "39.wav" / 2 messages (at 12h58m57 and 12h59m10)

Spectrum data available in the ATC recording bandwidth

The ATC recording has a short bandwidth dedicated to record human exchanges (voice data, from 100Hz to 3 kHz). However, some acoustic event (frequencies) coming from the propulsion system can appear in the spectrum of the background noise if the pilot leaves a period of time of silence long enough during its communication to the ATC center.

Typical acoustic event coming from the SA330J propulsion system

Some frequencies appeared in the spectra and were mainly coming from the following transmission parts (Image 6):

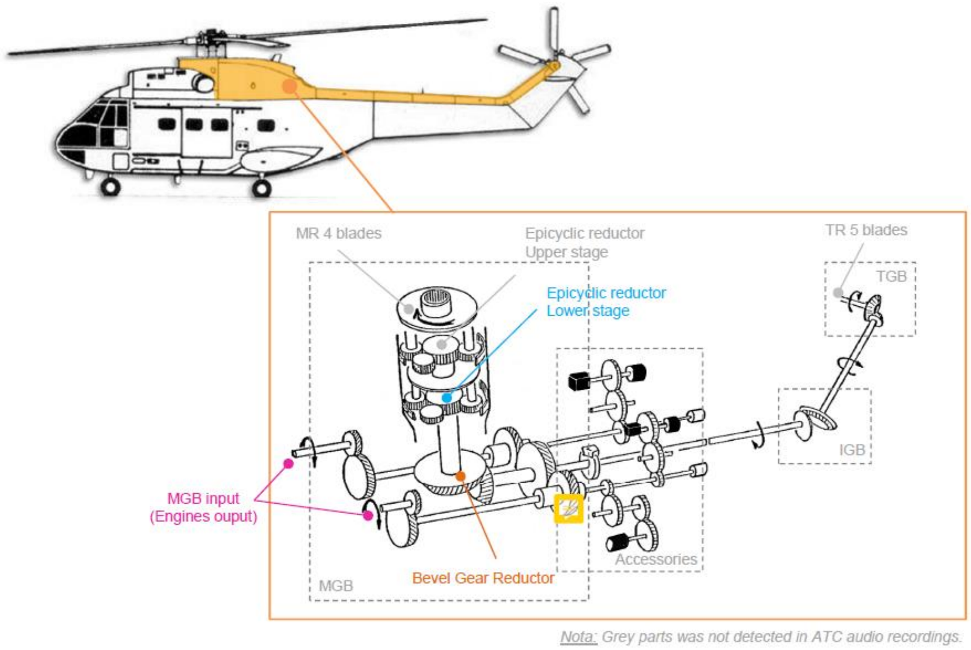


Image 6: MGB Source: operator

Example of a spectrum view (Image 7):

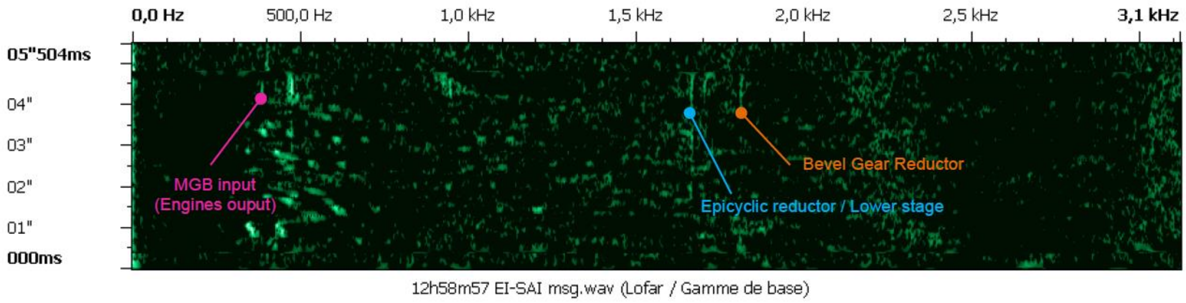


Image 7: Example of a spectrum view Source: BEA/FRAN

NR computation based on the Bevel Gear Reductor frequency value

In order to compute the NR value (% of the nominal NR), the following computation was applied:

(((*Bevel Gear Reductor frequency* / 405,77)*60)/265)*100 = **%NR**

Spectrum view

Spectra of the eight messages are detailed on **Appendix A**.

RESULTS

The table below shows the NR values for the helicopter during the last minutes (approximately four minutes prior to the accident) of the flight. These were established as follows, based on the ATC messages contents:

ATC time	Computed NR value
12 h 48 min 13	99,8 %NR
12 h 48 min 36	99,6 %NR
12 h 53 min 36	99,6 %NR
12 h 53 min 49	98,9 %NR
12 h 54 min 04	99,2 %NR
12 h 56 min 21	99,8 %NR
12 h 58 min 57	101 %NR
12 h 59 min 10	101,3 %NR

Note: It was not possible to establish the rotor speed information between two messages.

The figures above confirm that the helicopter engines were operating normally prior to the accident.

1.9 Test and research

Right main landing gear pivot examination

The objective of the examination was to determine the nature and the origin of the right main landing gear (Image 8) pivot fracture.

Right main landing gear pivot
Airbus Helicopters
P/N : -
S/N : -

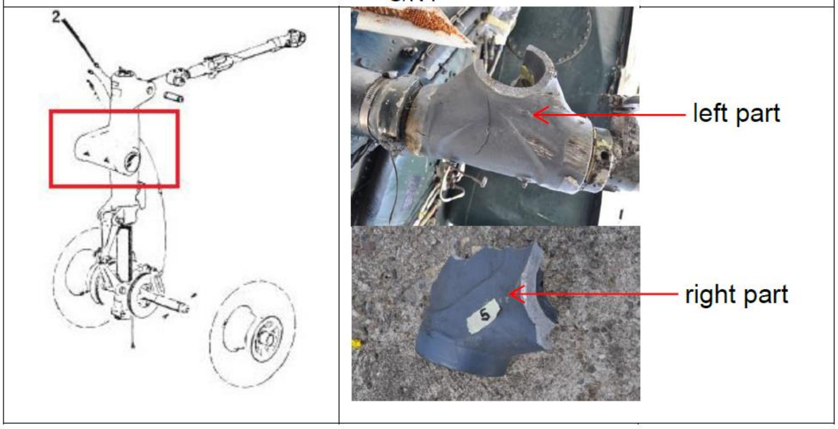


Image 8: Landing gear Source: BEA/FRANC

Work performed:

Fractographic examination

Two pieces from the pivot were transported to BEA France (referenced as the right part and the left part in the following). The examination of the matching fracture surfaces highlighted that at least one other piece was missing.
Binocular examination of the fracture surfaces showed a matt and granular appearance, characteristic of a sudden failure (**Appendix B**). Some local areas showed matting damage. It was not possible to determine the crack propagation direction, as only a few chevron markings were observed.

Results:

The fracture of the right main landing gear pivot was sudden, as a result of overload. There was no observation of any previous damage such as fatigue, corrosion or casting defect.

1.10 Wreckage and Impact Information

The wreckage of the helicopter was found at the beginning of RWY 35 (Image 9). Image 10 identifies the accident site location and Image 11 the final resting position of the helicopter.

Image 9: Overview of the helicopter on runway Source: Kosovo AAIIC

Image 10: event site Source: © 2017 Google LLC/AAIIC

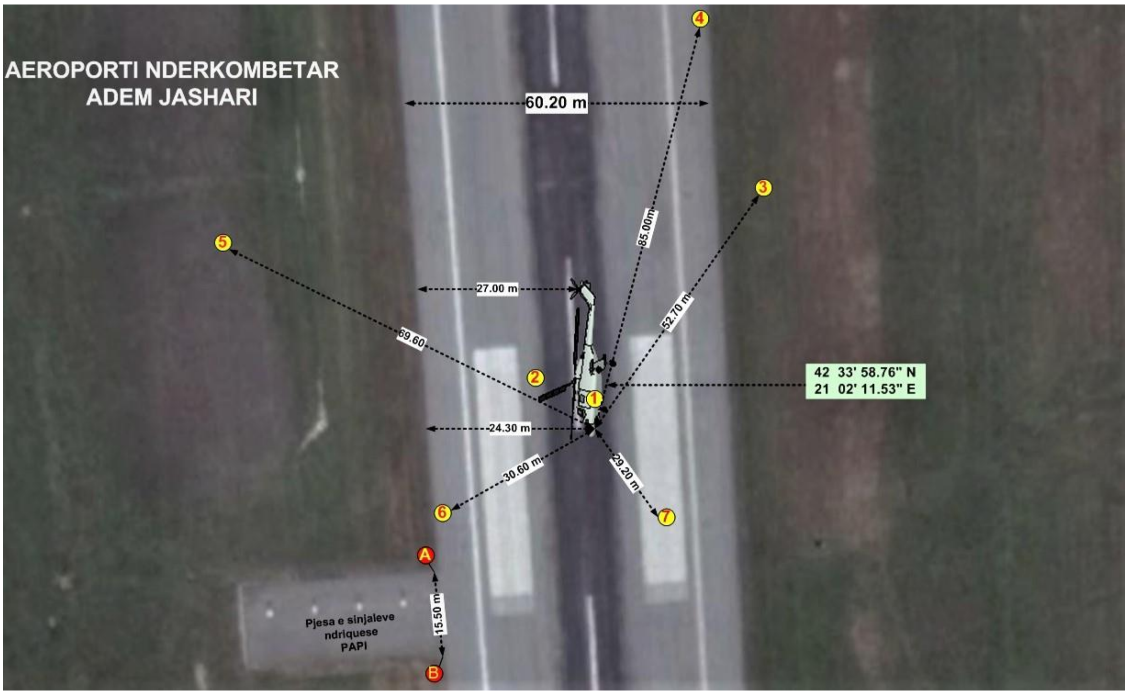


Image 11: Sketch of the final helicopter position Source: Google LLC/AAIIC

Measurement from sketch above:

Evidence #	Description of evidence	A	B
	Helicopter SA 330 J ; EI-SAI; SN 1545	36.30	48.90
	Damage to the track caused by the fall of helicopter	41.60	55.30
	Scattered parts of the helicopter		
	Scattered parts of the helicopter		
	Scattered parts of the helicopter		
	Scattered parts of the helicopter		23.40
	Scattered parts of the helicopter		
	Landmark, the northeast corner of the part of the asphalt where signal lights were called PAPI		

1.11 Organizational and management information

EULEX

The European Union Rule of Law Mission in Kosovo, EULEX Kosovo, was launched in 2008 as the largest civilian mission under the Common Security and Defense Policy of the European Union. EULEX's overall mission is to assist the Kosovo authorities in establishing sustainable and independent rule of law institutions. The Mission's current mandate has been launched to cover the period until 14 June 2020 based on Council Decision CFSP 2018/856.

EULEX mission had awarded a contract to a private operator, for provision of helicopter-services on a 24/7 basis in the region of Kosovo and neighboring states.

The Operator

The Operator is a multi-faceted aviation company that offers a range of helicopter services, through head offices in Ireland and South Africa. The company operates in different part of the world mainly through contract based operations for international companies and institutions. The Puma SA330 J is one of the main helicopters of their fleet through which they implement most of their contracts. The Operator has its own maintenance and training center facilities.

1.14 Additional Information

1.14.1 Procedures on OEI

The Operator provided the Investigation with a copy of its Operations Manuals. The following is an extract showing the procedure for Engine Failure after LDP (Image 12):

Issue 1 : Original
Amendment : Original
Effective Date : 28 October 2014

2.2.24. *Engine failure (OEI) after LDP*
Condition is detected by the associated Warning Light "ENG 1" or "ENG 2"

Collective Pitch	REDUCE TO KEEP RPM ≥ 250	PF

- Control Rotor RPM with Collective Pitch to keep RPM at 250 or above
- 255 NR is the min. drag NR
- At 220 NR AC-electric-system goes offline resulting in "AP" & "AP HYD" disengaging

Rotor RPM	CALL OUT	PNF

- Observe Rotor-RPM attentively and call out when RPM starts decreasing
- 255 NR is the min. drag NR
- At 220 NR AC-electric-system goes offline resulting in "AP" & "AP HYD" disengaging

Running Landing	PERFORM	PF

- Adjust speed to allow OEI-Landing within available space
- Assure maximum 10° nose-up attitude
- Aim for touchdown NR ideally at 250 NR
- Cushion landing with collective & land at minimum speed for power available
- After landing lower collective fully, centralize controls, apply wheel brakes

Engine Shutdown Procedure	Perform	BOTH

- Perform ENGINE SHUTDOWN PROCEDURE 03.08.01

Further actions	CONSIDER	BOTH

- Consider and evaluate the actual situation after Engine Shutdown by all feasible means
- Take actions accordingly

Image 12: Engine Failure after LDP Source: Operator

1.14.2 Operation Manual B & D

The Operator provided the Investigation with a copy of its Operations Manuals. The following is an extract from Manual B showing the procedure for Engine Failure OEI landing (Image 13):

4.5.6.4. Engine failure – OEI landing

Flight Event	PNF	PF
On stabilized approach at 45 knots, descending through 200 ft	"200 feet to go, stabilized approach"	
Engine Out tone and light	"Engine Failure" cancels tone	
PF decides to land		"Engine failure continuing. Immediate actions"
No fire	"Checking for signs of fire…no fire. Memory items complete"	Maintains normal approach angle and speed at 45 knots, 300-500 fpm.
Descending through 50 feet rad alt	"50 feet"	Begins flare with maximum nose up of 10° below 30 feet to reduce speed as much as possible
Just before touchdown	Monitors landing and calls pitches of 10° nose up	Lowers nose for run-on landing.
Aircraft on ground		Smoothly lowers collective and brakes as required.

Image 13: Engine Failure after LDP Source: Operator

The following is an extract from Manual D showing the procedure for Engine Failure in flight- simulating OEI:

3.5.6. **Engine failure in flight – simulating OEI**
The Training Capt/Flight engineer shall normally keep one hand on the throttles during practice OEI operations below 500 feet AGL. However he shall keep in mind the possibility of having to take control of the aircraft close to the ground in the event of mishandling by the trainee. If the aircraft is fitted with an OEI training device, it must be used for all OEI simulations. Pilots shall monitor the Ts & Ps in order to ensure that all parameters are maintained within RFM limitations and that the "good" engine is not unduly stressed. The intentional use of actual OEI limits is prohibited, except in an actual emergency.

Image 14: Engine Failure in flight Source: Operator

1.14.3 Emergency procedures – Failure of an engine during Approach – After the LDP

The Operator provided the Investigation with a copy of its Flight Manual. The following is an extract AFM showing the procedure for an Engine Failure after LDP (Image 15):

aerospatiale Hélicoptères — Puma — FLIGHT MANUAL

3. FAILURE OF AN ENGINE DURING APPROACH

The approach and go-around path profiles versus weight and prevailing conditions at the field are given in "PERFORMANCE" section.

Recommended approach speed during descent is 80 km/h (43 knots).

A. On a clear heliport

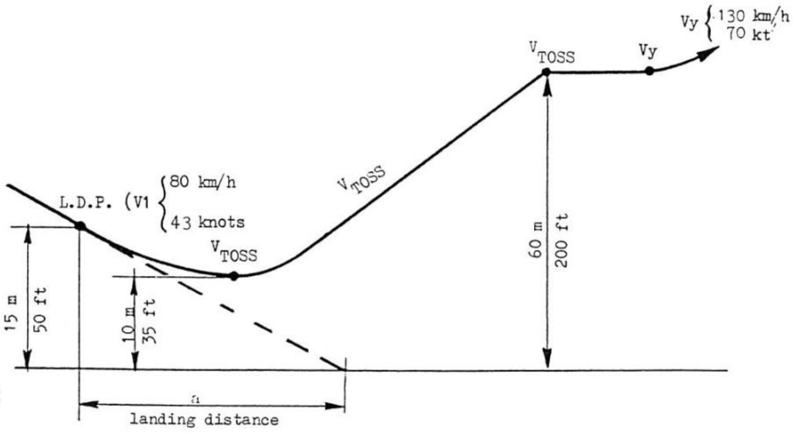
Landing decision point L.D.P. { V1 = 80 km/h (43 knots) ; h1 = 15 m (50 feet) }

(1) Before L.D.P.

With the aircraft at maximum weight authorized by the limitations due to performance (maximum take-off weight, given in the section entitled "LIMITATIONS").

It is possible :

- Either to land, (see normal landing procedure).
- Or, to maintain the safety speed (VTOSS) when landing is impossible.
  Procedure :
  = Increase collective pitch. Do not allow the rotor speed to drop below 255 rpm.
  At the same time, maintain VTOSS.
  = . Permissible Ng : 2.5-minute rating
  = Continue to climb until Vy is obtained (see recommended procedure in case of failure of one engine on take-off).



(2) After the L.D.P.

Any failure after the landing decision point on approach, requires IMMEDIATE landing. Adopt the same procedure as that recommended in case of failure of an engine on take-off before the C.D.P.

330J SUPP. 1

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Image 15: Engine Failure after LDP Source: Operator

1.14.4 Operation Manual of The Operator: Supplement 01 – Helicopter emergency Medical Service (HEMS) Operations

The Operator provided the Investigation with a copy of its Operations Manuals Supp. 01 for HEMS operation. The following is an extract showing the Categories of passengers – Medical passengers (Image 16):

1.1.7. *Categories of passenger*

1.1.7.1. Pilots
Pilots are the aircraft operating crew.

1.1.7.2. Medical passengers
SPA.HEMS.135 (a)
In the context of the SAI role in Kosovo, Medical Passengers are passengers who have been trained and are qualified to categorise a flight as a HEMS flight. When a qualified Medical Passenger is on board, the flight may be classified as either an Air Ambulance flight or a HEMS flight. However Medical Passengers will not perform aviation tasks.

1.1.7.3. Patients
SPA.HEMS.135 (c)
Patients are CAT passengers who may be carried on HEMS flights. Personnel involved in the rescue, extraction or movement of a HEMS patient (e.g. Firemen, and MRT members) may be carried on a HEMS flight (see paragraph 1.1.3.c).

1.1.7.4. Passengers
All other passengers are CAT passengers and may not be carried on HEMS flights. However, alleviation is allowed in cases where it may be expedient to carry parents or guardians of infants who are patients.

Image 16: Categories of passenger Source: Operator

It shows that when a qualified medical passenger is on board, the flight may be classified as either an Air Ambulance flight or a HEMS flight.

The following is an extract showing and training for medical passengers (Image 17):

1.4.8. *Training requirements*

1.4.8.1. Medical Passengers
AMC1.1 SPA.HEMS.135 (a)

The Safety Briefing as outlined above must include the following:
a. Familiarisation with the helicopter type(s) operated;
b. Entry and exit under normal and emergency conditions both for self and patients;
c. Use of the relevant on-board specialist medical equipment;
d. The need for the Commander's approval prior to use of specialised equipment;
e. Method of supervision of other medical staff;
f. The use of helicopter intercommunication systems; and
g. Location and use of on-board fire extinguishers.

Image 17: Training requirements for medical passengers Source: Operator

1.14.5 Requirement for FDR

The Investigation notes that under COMMISSION REGULATION (EU) No 965/2012 of 5 October 2012 *laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council*, SECTION 2, *Helicopters*, CAT.IDE.H.100 *Instruments and equipment*, CAT.IDE.H.190 *Flight data recorder*, the subject Helicopter is not required to be fitted with a Flight Data Recorder, as it was manufactured in 1978.

Also according to MEL (Image 18) of the Operator the helicopter is not required to be fitted with a Flight Data Recorder

Issue 1 : Original
Amendment : Original
Effective Date : 01 December 2012

STARLITE AVIATION GROUP

1 System & Item Sequence Numbers	2 Rectification Interval	3 Number Installed	4 Number Required for Dispatch	5 Remarks or exceptions
5. Flight Data Recorder	B	1	0	*May be inoperative provided Cockpit Voice Recorder is installed and operative
6. Elapsed Timer	C	1	0	*May be inoperative provided Clock is operative.

Starlite Aviation Ireland Limited
Minimum Equipment List – Aerospatiale SA-330J

Page | 2-4
Doc Ref: IA3-01

Image 18: Minimum Equipment List (MEL) Source: Operator

1.14.6 Dynamic Rollover

According to the FAA Rotorcraft Handbook-6, dynamic rollover refers to the susceptibility of a helicopter to lateral rolling in certain conditions. The roll is initiated by an external event, which causes the helicopter to pivot about a skid or landing gear wheel. Once the angle of roll exceeds a critical value, thrust from the main rotor causes the roll to continue and recovery becomes impossible.

2. Analysis

2.1 General

The helicopter had been scheduled to carry out a recurrent training flight. A qualified training captain, who was the designated PIC of the flight, was sitting in the left seat of the helicopter . He was also acting as PM. A qualified captain was sitting in the right seat, and was acting as PF. The Operator informed the Investigation that a flight simulator for the subject helicopter type, was not available for the Operation in Pristina and training was performed using one of the helicopters stationed at Pristina. The Operator also informed the Investigation that it was custom and practice to carry two HEMS medical crew as passengers on training flights in case the mission needed to be re-classified as a HEMS flight during training.

There were no known mechanical or technical defects with the subject helicopter, prior to the accident. Sound spectral analysis indicates that both the engines and main rotor were operating normally prior to the accident.

The helicopter was undergoing simulated engine failures, as part of the recurrent training flight. The flight was performing a circuit to RWY 35 at BKPR during which the Flight Crew had briefed that the PIC would reduce the number one engine power to idle, below LDP, and the procedure would be for the PF to continue the approach to a run-on landing. LDP was determined as 100 ft above ground level, and power on the number one engine was reduced to idle at approximately 80 ft agl.

In general terms, the procedure for a simulated engine failure after LDP requires that;

- Speed is adjusted to allow a OEI run-on landing within the available space
- Maximum nose up attitude 10° (To avoid tail strike)
- Aim for touch down NR ideally at 250 NR
- Cushion landing with collective and land at minimum speed for power available
- After landing lower collective, centralize controls and apply breaks.

Following the simulated engine failure, and as the helicopter came over the start of the runway the rate of descent was perceived by the PM as higher than normal and full collective was selected by the PIC, in order to cushion the touchdown on the runway surface. The touchdown was described as ‘firm’, and, the helicopter became airborne again..

As the helicopter was performing a run-on landing, it was still moving forward during the bounce. As full collective was still selected during the touchdown, the helicopter commenced a left rotation about the yaw axis. Forward cyclic stick was applied during the bounce, to ensure that the Helicopter did not sustain a tail strike. The second touchdown was reported as being on the nose gear. The collective was lowered during the second touchdown. With a left yaw, and forward motion on the helicopter, it is considered likely that the second touchdown on the nose gear accelerated the left yaw, and possibly also contributed to the commencement of a right roll.

Following this, it is likely that the helicopter's right main landing gear made contact with the runway surface. Due to the dymanic attitude of the helicopter (left yaw and right roll) the right main landing gear sustained an overload force, and collapsed. This contributed to the right roll increasing and the helicopter entered a dynamic roll-over. Recovery was not possible and the helicopter came to rest on its right hand side.

The brief for the simulated engine failure after LDP was for the helicopter to touch down at the mid-runway point. However, the final resting position of the helicopter was within the first quarter of the runway. The PIC identified that in the latter stages of the approach, the rate of descent was higher than normal, and thus he had to apply full collective to cushion the landing. In addition, the PIC confirmed that the helicopter ‚flared a little too much...the helicopter came to an almost stop. It is therefore considered likely that the initial flare prior to touch down was higher than the maximum 10° required for the run-on landing. An increased flare will reduce ground speed and lift over the rotors, thereby necessitating increased collective to maintain height. If the available collective lift is insufficent, the rate of descent will increase causing a firm hard landing. The combination of a bounced landing, the application of full collective with decaying NR to cushin the landing, a high centre of gravity and a narrow tricycile undercarriage, all contributed to the risk of dymanic rollover as was the case in this particualr accident.

2.2 Carriage of Passengers During Training Flights

The Investigation notes that medical crew passengers were being carried during a flight detail that involved practice engine failures. During such OEI training there are additional risks, and the Investigation is of the opinion that, as such, the carriage of passengers is not appropriate. In addition, following the accident, the passengers did not immediately evacuate the helicopter. The passengers had previously been carried on the helicopter used by the Operator, and would have been briefed on what to do following an emergency. It was not determined why the passengers did not immediately exit the aircraft, but it is possible they were experiencing shock following the event.

The Investigation therefore makes the following Safety Recommendation to the Operator:

That Starlite Aviation should ensure that passengers are not carried on flights involving simulated engine failures, or other flight training exercises that expose the helicopter to additional risk.

2.3 Lack of FDR Data

The Investigation was informed by the Operator that there was no FDR fitted to the helicopter according to MEL, nor under extant regulations, was one required.
However, a full understanding of the accident sequence, including flight control inputs by the Flight Crew, the motion, and the loads being experienced by the helicopter were not available to the Investigation. HUMS data was also not available to the Investigation.
The Investigation therefore makes the following Safety Recommendation to the European Commission:

That the European Commission ensure that as part of a contract for supply of aviation assets for EU missions, such assets are equipped with Flight Data Recording equipment as standard.

3. Conclusions

3.1 Findings

- Both Flight Crew members were qualified for the flight duty.
- There were no known mechanical or technical faults with the Helicopter prior to the accident.
- The Operator informed the Investigation that there was no simulator available for Flight Crew undergoing recurrent training on the SA330 J at BKPR.
- The flight detail was a recurrent training flight.
- The training detail included simulated engine failures.
- There were two HEMS medical crew passengers on board.
- The Helicopter was performing an engine failure below LDP to an unrestricted landing area, which involved a continuation to a run-on landing.
- During the simulated engine failure below LDP, the PIC perceived that the helicopter descent rate was higher than normal.
- This high rate of descent was initiated as a result of excessive flare which brought the helicopter to an almost stop.
- To assist the PF in arresting the rate of descent, the PIC pulled full collective.
- The helicopter performed a firm touchdown, following which it bounced.
- With full collective still selected, the helicopter commenced a left rotation about the yaw axis.
- Forward cyclic stick was selected to prevent a tail strike.
- The helicopter touched down a second time with its nose landing gear first, during which the collective was lowered. The helicopter was still experiencing a left rotation, and likely commenced a slight right roll.
- As the helicopter was still moving forward, as part of the run-on landing, when it contacted the runway, the right main landing gear experienced an excessive side load.
- The right main landing gear leg failed under over-load.
- The helicopter continued the left rotation about the yaw axis, and the right rotation about the roll axis increased.
- The helicopter entered a dynamic roll-over, from which recovery was not possible.
- During the roll-over, as the main rotors contacted the runway surface, the Flight Crew commenced an immediate engine shut-down.
- The helicopter came to rest on a heading of 350 degrees, within the first quarter of the runway and close to the center-line.
- The Flight Crew exited the helicopter through the left cockpit door.
- The two HEMS medical crew passengers did not immediately exit the helicopter, and the PIC returned to the helicopter to instruct them to leave.

- There was no fire.

3.2 Causal Factors

Dynamic Roll-Over following bounced landing during OEI below LDP exercise.

3.3 Contributory Factors

Over-flaring of helicopter in preparation for a run-on landing

4. Recomandation(s)

Note: In accordance with Law No. 03/L- 051 on Civil Aviation of Republic of Kosovo, and the article 17.3 of regulation (AAIIC/OPM) NO.01/2017 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation shall no in case create a presumption of a blame or liability for an accident, a serious incident or an incident. The addressee of a safety recommendation shall inform the safety investigation authority which issued the recommendation of the actions taken under consideration under the conditions described in the Article 18 of the aforementioned Regulation

4.1 Training procedure

During the flight exercise two medical where onboard. Consequentluy AAIIC recommend that:

Safety Recommendation AAIIC 2019-03

That Starlite Aviation should ensure that passengers are not carried on flights involving simulated engine failures, or other flight training exercises that expose the helicopter to additional risk.

4.2 Lack of FDR Data

FDR and HUMS data was not available to the Investigation to understang the accident sequesnce. Consequentluy AAIIC recommend that:

Safety Recommendation AAIIC 2019-04

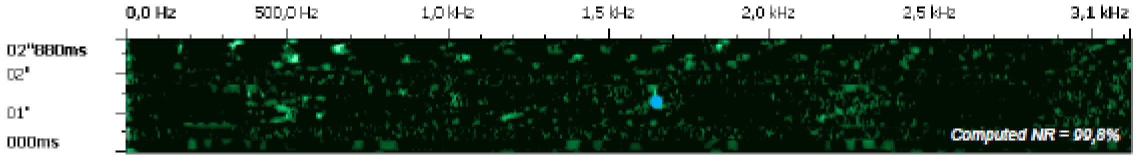
That the European Commission ensure that as part of a contract for supply of aviation assets for EU missions, such assets are equipped with Flight Data Recording equipment as standard.

Investigator in charge:	Arben Gashi Aeronautical Accident and Incident Investigations Commission (AAIIC) of Republic of Kosovo
FDR and CVR:	BEA/France

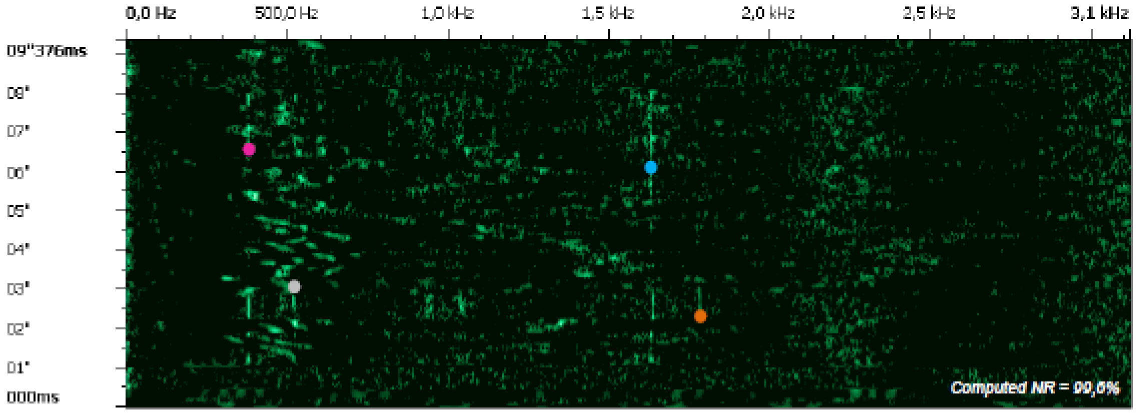
Appendix A

Spectra view of the EI-SAI messages

● Epicyclic Lower stage reductor ● MGB Input ● Bevel Gear reductor ● Not determined



12h48m13 EI-SAI msg.wav (Lofar / Gamme de base)



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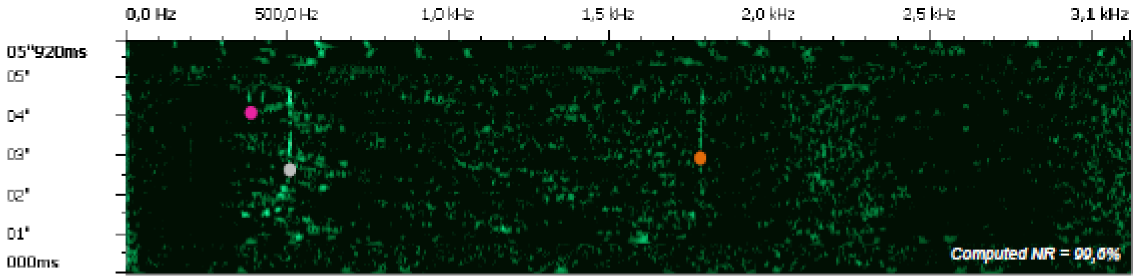

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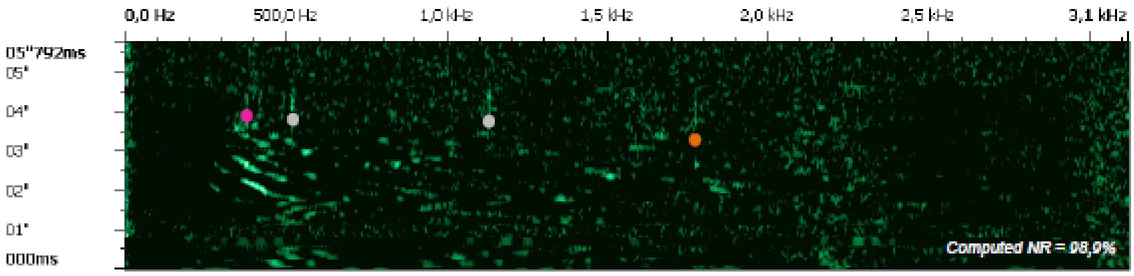

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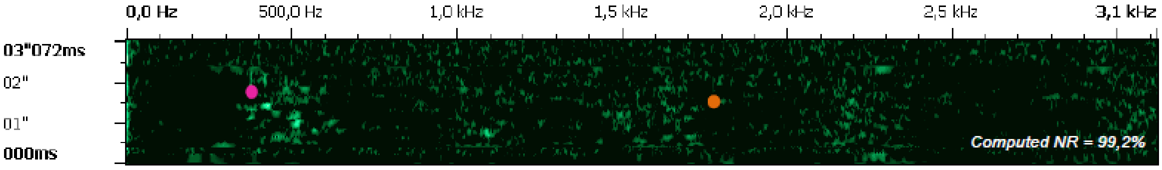

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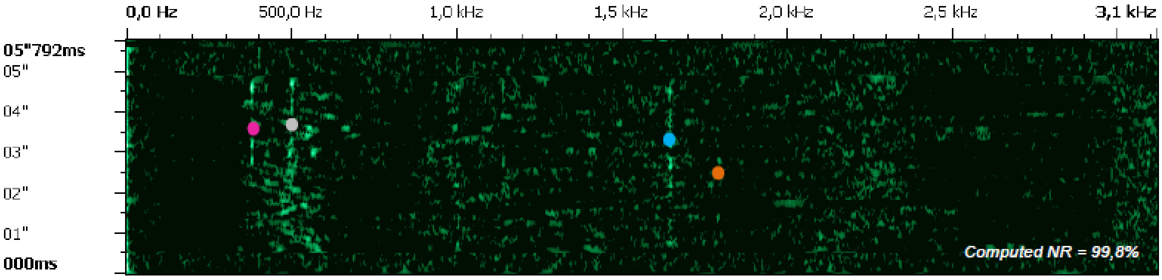

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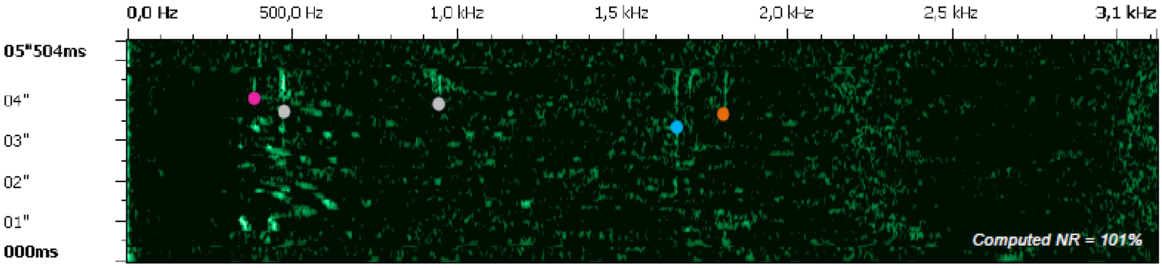
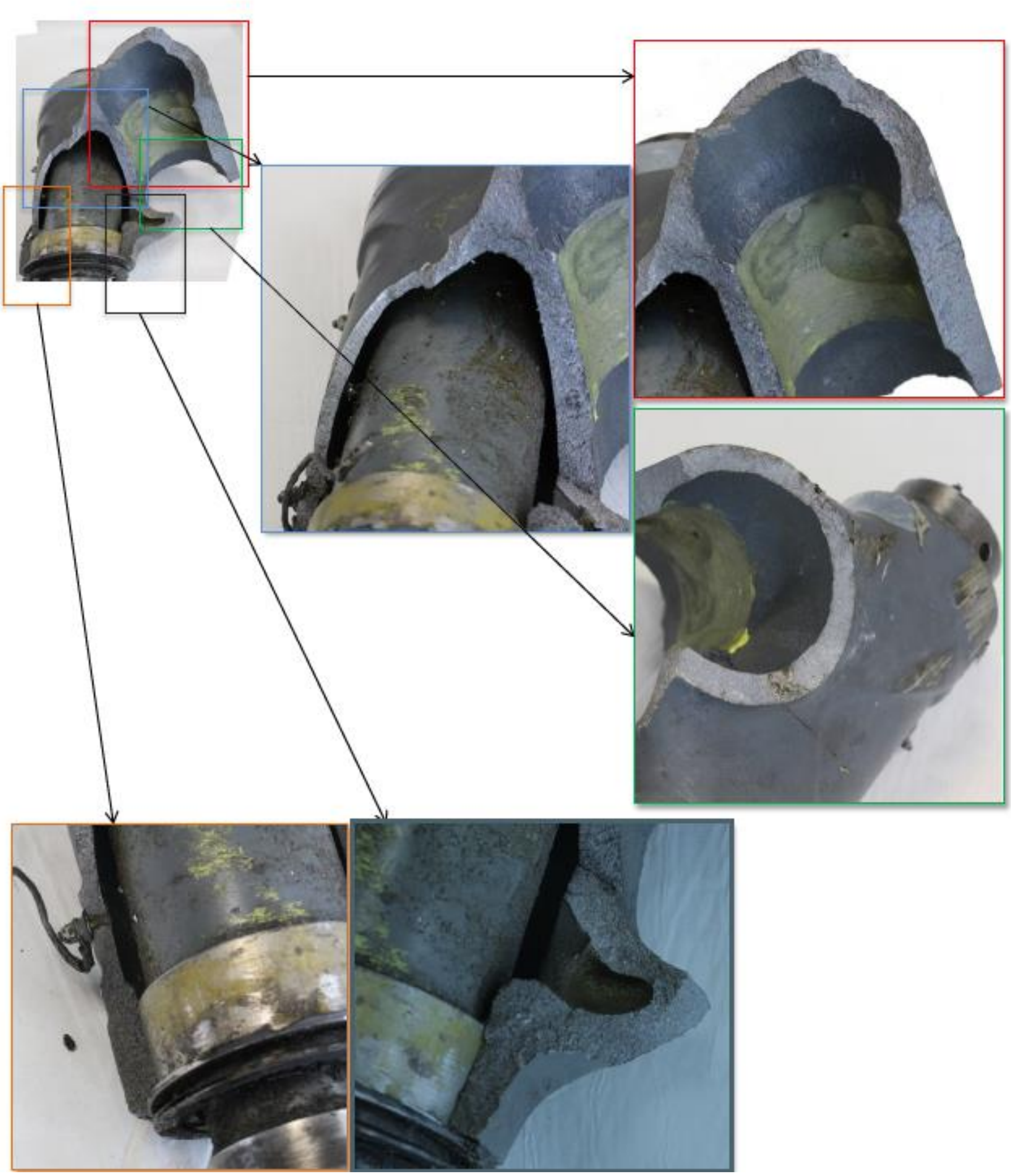
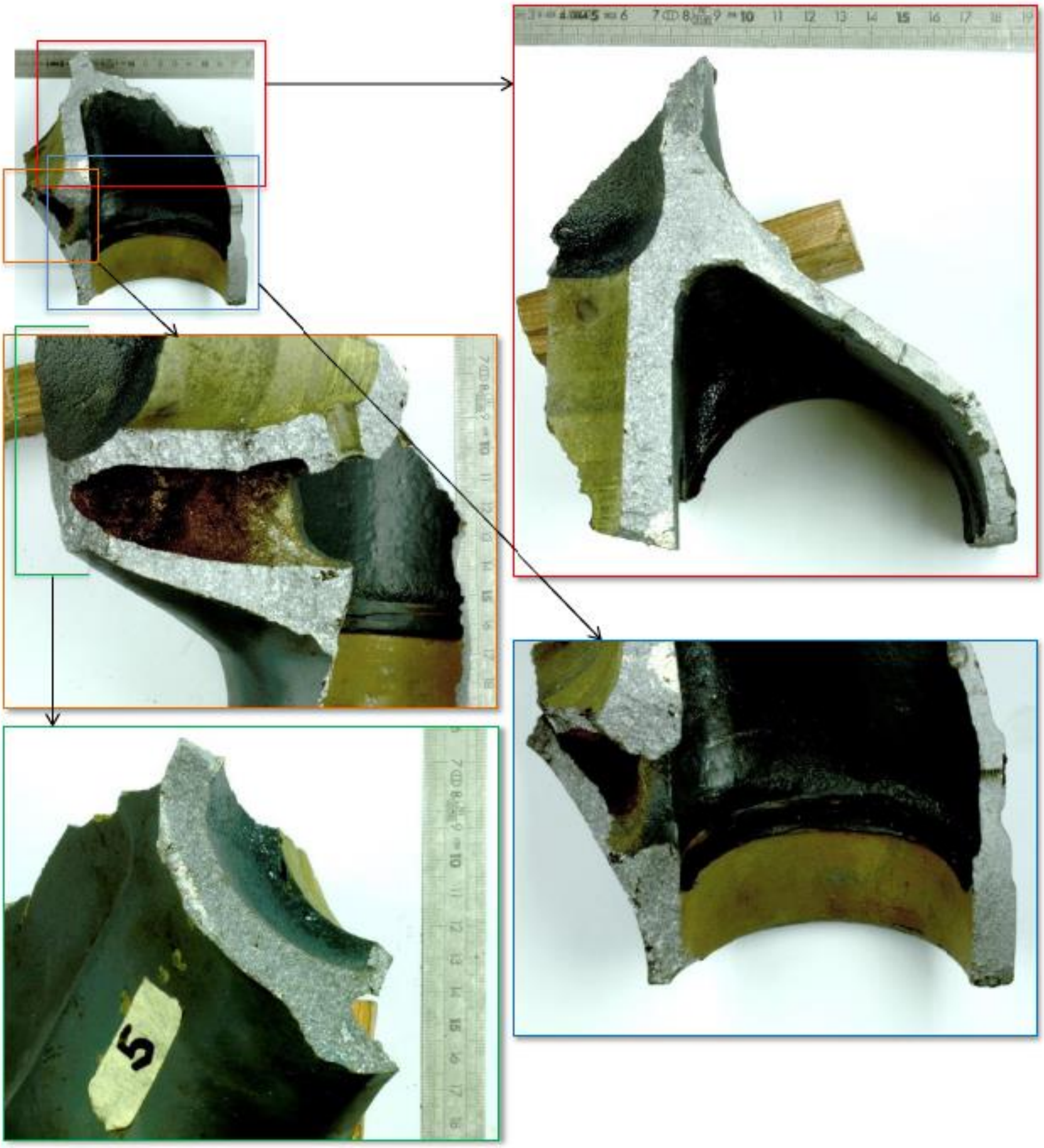


12h58m57 EI-SAI msg.wav (Lofar / Gamme de base)

Appendix B

Fractographic examination of the left part of the right main landing gear pivot (Source: BEA/FRANCE)




5