CIVIL AVIATION ACCIDENT REPORT
No. FMA/AIPB/394

FEDERAL REPUBLIC OF NIGERIA

MINISTRY OF AVIATION

FINAL REPORT ON THE ACCIDENT TO THE
AERO CONTRACTORS COMPANY OF NIGERIA'S
AS-365-N2 DAUPHIN HELICOPTER REGISTERED 5N-BBS
AT AGIP OIL BASE, BRASS TERMINAL, BAYELSA STATE,
ON FRIDAY 3RD JANUARY 2003.

:DERAL MINISTRY OF AVIATION

Accident Investigation & Prevention Bureau

:deral Secretarial Complex, Shehu Shagari Way, Maitama, Abuja. Tel/Fax: 09- 5238568

FMA/AIPB/394 16th May, 2005

.... Date:...

Honourable Minister,
Federal Ministry of Aviation,
Federal Secretariat Complex,
Shehu Shagari Way,
Maitama, Abuja.

Honourable Minister, sir

CIVIL AVIATION ACCIDENT REPORT NO.FMA/AIPB/394

I have the honour to present the final report on the accident to Aero Contractor Company's AS-365-N2 Helicopter registered 5N-BBS, which occurred at Agip Oil Base, Brass Terminal Bayelsa State on Friday 3rd January, 2003.

2. Sir, the investigation was conducted by a host of International Accident Investigators representing:

(i)	BEA	-	The French Accident Bureau
(ii)	Schreiner Aviation Group BV	-	The aircraft owner
(iii)	Eurocopter Company	-	The Aircraft Manufacturer
(iv)	Turbomeca (SNECMA)Group	-	The Engine Manufacturer
(v)	AERAZUR	-	The Emergency Floatation Gear Manufacturer
(vi)	CROUZET AUTOMATISMES	-	The G-Switch Manufacturer
(vii)	AIPB	-	The Accident Inspector-In-Charge.

3. Although, there were differences and disagreement of opinions by the participating Accident Inspectors, but most of these have been resolved and the recurring ones have been presented in the "Addendum" - page 109 of this report.

4. Nigeria, being the country of occurrence, has the mandate by the ICAO ANNEX 13 convention to compile and write the Final Report as presented herein.

Yours respectfully.

R. Faminu
Deputy Director (AIPB)

FINAL REPORT ON THE ACCIDENT TO THE AERO CONTRACTOR COMPANY OF NIGERIA LIMITED'S AS-365-N2 HELICOPTER REGISTERED 5N-BBS AT BRASS OIL TERMINAL, BAYELSA STATE ON FRIDAY 3RD JANUARY 2003.

Aircraft Data

Type:	-	AS 365N2 (DAUPHIN)	
Serial No:	-	6448	
Date of Manufacture:	-	June 1993	
Registration:	-	5N - BBS	
C of A Validity:	-	19 June 2003	
Total Airframe Time:	-	6,320:32hrs	
Airframe Cycle	-	3,987 Landings	
Manufacturer:	-	Eurocopter Company 13725 Marignane, France.	
Owner:	-	Schreiner Airways BV 1 Diamantlaan 2132 WV Hoofddorp Netherlands.	
Operator:	-	Aero Contractors Company (Nig.) Ltd. Murtala Mohammed Airport General Aviation Terminal Ikeja, Lagos.	
Engines			
Type:	-	Arriel 1C2	
		No. 1	*No. 2*
Serial No:	-	12134	12148
Year of Manufacture:	-	1991	1993
TSN	-	5196hrs	2493hrs
CSN	-	5116Cyc.	3067 Cycles
Souls on Board:	-	12	
Place of Accident:	-	Brass Terminal, Bayelsa State.	
Geographical Location:	-	04° 18"N 006° 14"E	
Date and Time:	-	3rd January 2003, @ 1335hrs UTC.	

Personnel Information

Pilot- in-Command

Age:	-	8^{th} December, 1946 (56yrs)
Nationality:	-	Indian
License:	-	ATPL No. 4419(H)
Ratings:	-	SA 365N and AS 355F
Last Medical:	-	29^{th} November 2002
Validity	-	11^{th} June 2003
Total Flying Time:	-	11,420Hours
Time on Type:	-	3,898 hrs
Time Last 28days	-	75hrs

Co-pilot

Age:	-	23^{rd} June, 1963 (39yrs)
Nationality:	-	Beninoise
License:	-	CPL No. 4485/H
Ratings:	-	Dauphin SA 365
Last Medical:	-	7^{th} August 2002
Validity	-	13^{th} February 2003
Total Flying Time:	-	4,215 Hours
Time on Type:	-	3,601Hours
Time last 28 days	-	64hours

Chapter one

1.0 Factual Information

1.1 History of the flight

The 5N-BBS Dauphin Helicopter was operating for the Nigeria Agip Oil Company (NAOC) on the day of the accident and Aero Contractor Company of Nigeria Ltd was the operator of the aircraft. The flight schedule was Port-Harcourt – Bintang Kalimantan (BK) Oil Terminal - Brass Terminal – Port Harcourt. The operations of the first two sectors of the schedule were normal with the aircraft arriving at Brass Terminal at 1235 hours and departing at 1324 hours UTC, enroute to Agip Port Harcourt Base. It remained on ground at the Brass Terminal for approximately 50 minutes.

At 1324hours, BBS' engines were started and the aircraft was actually airborne at 1325.13hours. The aircraft took off from Brass Terminal with the Commander on the controls and there were 12 souls on board with Port Harcourt as destination. At 1328hours, about 49 seconds after take-off, the co-pilot requested to take over the control, which was handed to him under normal circumstance of operation and he, the co-pilot leveled out at 700ft. About 6 minutes into the flight, the CVR was apparent to have stopped working without the crew knowing about the problem. Approximately 10 minutes into the flight, passengers claimed that they heard a loud bang from the aircraft, with an attendant that the helicopter rolled and yawed from right to left, which would have prompted the commander to take over the control. Then in a quick succession of decision-making, the crew started to turn the aircraft back to Brass Terminal. After a few seconds, the co-pilot turned his head and addressed the cabin to assuage the passengers' apprehension, saying that everything was OK, that they were in total control of the helicopter and that they were going back to Brass to land. Some passengers claimed to have perceived a smelling sensation of burning oil; at the same time, the aircraft was observed climbing and making a turn-around back in the direction of Brass Terminal. The bang noise was not recorded on the CVR tape.

A sister aircraft, 5N-ESO, which was enroute Agbara (another production platform about 22nm SSE of Brass) heard the 5N-BBS over the VHF radio calling "MAY DAY! MAY DAY!" This distress call was closely followed by 'Oh my God. Shit! Shit! The floats, floats, floats, My God'. The Commander of ESO, another company helicopter was on the radio and advised the BBS' Co-Pilot to "relax, cool down, what is happening?" Then the Co-Pilot requested that ESO should look for BBS in the river. The only pronouncement made by the distressed aircraft's Commander during the whole episode was "I'm trying to make it to the Helipad."

A security Police personnel attached to the Terminal, who was sitting outside his office when BBS was taking off gave evidence that, when the helicopter was now coming back on the emergency landing, there were some orange colored objects attached to the sides of the aircraft and was moving in a sideways attitude. As this was unusual to him, he thought that the helicopter was carrying orange coloured cylindrical plastic gerry-cans, as he was scared to see the helicopter "started to rotate to the left" so he scampered inside for cover then heard the crashing sound.

Prior to the arrival of the helicopter and its eventual crash at the harbor, 5N-ESO was already on its way to Brass and came overhead Brass Terminal in search of the aircraft but could not locate BBS there. Then 5N-ESO decided to fly back to Port Harcourt while looking out for the aircraft on that route without any success. After about 6 minutes, the Commander realized he needed to pick up fuel from Brass and therefore flew back to Brass. On arriving overhead Brass, the co-pilot sighted the already crashed helicopter laying inverted in the water with the landing gear and floats clearly visible.

According to a survivor's account, when the aircraft was on short final, there was another bang whereupon the aircraft reportedly lost its directional control and started to spin to the left and eventually crashed into a 20-foot steel container on a barge. It appears that the Captain was aiming the aircraft to land on the Brass Terminal Helipad. The helipad is about 60 meters away from the point of the crash, or the aircraft could have lost its directional control.

1.2 Injuries to Persons.

Injuries	Crew	Passengers	Others
Fatal	**2**	**2**	**Nil**
Serious	**Nil**	**1**	**Nil**
Minor/None	**Nil**	**7/0**	

1.3 Damage to Aircraft

The helicopter suffered total structural damage. Investigation of the wreckage shows that serious impact damage was done to the starboard of the cockpit section; while the port and the cabin area were relatively intact. Examination of the cockpit depicted the No. 2 throttle lever in the emergency range and No. 1 throttle in idle position. The tail boom, the tail rotor gearbox/blades and the fenestron were completely destroyed.

1.3.1 Main Rotor Blade (MRB)

The four main rotor blades were made of composite material and were all shredded from the hinges to the tips due to impact with the container and the fragments were scattered all over the accident site.

1.3.2 The Tail Boom

The tail boom was totally fractured from the fuselage while the tail rotor gearbox was also detached from the boom. The tail rotor drive shaft and the tail rotor blades pitch-control shaft were severely damaged. The tip of the vertical stabilizer had been chipped off.

1.3.3. Main Transmission Gearbox (MTGB)

The main transmission gearbox appears to be intact except the right hand gimbal attachment, which was broken, was due to the impact of the crash.

1.3.4. The Engines

The two engines were immersed in the salty river but appeared intact and clean while there was no evidence of fire on them. The engines were, however, shipped to the manufacturer's facility of Turbomeca in France for detailed investigations.

1.3.5. The fuselage

1.3.6. Investigations of the damage wreaked on the fuselage clearly show that the aircraft had made a starboard impact with the container on the barge. The doorframe of the Captain's side was crushed inwards with fracture on the mid-upper section. The middle passenger door crumbled, while the rear sliding door sheared off the main fuselage. The luggage compartment door was forcefully severed off by the impact with the container structure. Except for the windshield, all other glassware on the aircraft were shattered.

1.4 Other Damage

The 20-foot container structure on the barge, which the aircraft impacted with, was substantially damaged. There was also environmental pollution of the Nembe Creek by aviation fuel and oils.

1.5.0 Personnel Information

1.5.1 Pilot-in-Command

The pilot-in-command was a 56-year-old Indian male with a Nigerian validated Airline Transport Pilot Licence (ATPL) No. 4419H (Helicopters), which was valid until 11th June 2003. He had his last medical examinations on 29th November 2002 and was found medically fit but with a restriction of wearing a correcting spectacles.

As at the time of the accident, the commander had a total flying experience of 11,420 hrs out of which he had 3,898 hrs on type. He had been in the employment of the company since 13th January 1993. He had three more days to work before proceeding on off duty come 6th January 2003. He would have been off for another 4 weeks of rest period. Sometimes in the year 2000, the company disciplinarily suspended his command privilege and when the suspension was lifted he was demoted to a senior first officer. He was reinstalled as Commander after complying with an extensive company-training program. He had his aircraft ratings on AS 365N and AS 355F helicopters. He had logged a total of 74.5 hours flying time in the last 28 days.

1.5.2 The Co-Pilot

The co-pilot was a 39-year-old Beninoise national male with a Nigerian Commercial Pilot License number 4485(H), which was valid until 13th February 2003. He joined Aero Contractors Company Nigeria Ltd. on the 25th September 1995 and had his last medical examinations on the 7th August 2002 and was found medically fit with no restriction or limitation imposed on him. He had his last proficiency check on the 31st July 2002. He was type rated on Dauphin AS 365 and had a total flying experience of 4,215 hours and type experience of 3,601 hours. In the last 28 days, the co-pilot flew 64 hours

The Co-Pilot was given a VMC proficiency Check on the 31st July 2002 and was advised by the examiner that "it was not advisable to commence command training at the present juncture, primarily due to the inadequate knowledge of the Aircraft Flight Manual (AFM), with particular reference to Emergency Procedures".

1.6 Aircraft Information

The aircraft AS-365-N2 Dauphin, serial numbered 6448 was manufactured in 1993 by Eurocopter Company in France and entered into the Nigerian register as 5N-BBS on the 13th July 2000, While its first Certificate of Airworthiness in Nigeria was issued on the 20th July of the same year and currently valid till 19th June 2003. The helicopter was powered by two Arriel 1C2 engines manufactured by Turbomeca (Snecma Group), France. The helicopter was certificated for a maximum all-up weight of 4,250 kilogram i.e. (9,350 lbs.). It was certificated for single-pilot operation, but for the public transport category on its certificate by NCAA approval, Aero Contractor of Nigeria Ltd operates the helicopter with two pilots.

For over water operation provision, the aircraft was equipped with four gear floatation system, which can be inflated simultaneously, either by activating the collective lever switch, or by the switch on the instrument floats control panel. To enable float operation over water, the switch is selected in the "ARM" position to be ably deployed by the collective lever switch or by the instrument panel mounted float switch.

Aero Contractors Company Nigeria Limited is NCAA Approved Maintenance Organization (AMO), therefore, has been maintaining the aircraft at its AGIP base in Port Harcourt. As at the time of the crash, the aircraft had accumulated a total airframe time of 6,320hrs and 3,987 landings. There was no known defect recorded neither against the airframe, nor against any of its two engines before embarking on the eventful flight from Brass

Terminal. The center of gravity of the aircraft was found to be within the prescribed limit at the time of the crash.

1.7 Meteorological Information

There were no formal meteorological data available for most of the offshore operations, but the weather information as prevailed during the period of the crash is as follows:

Time (GMT)	-	13:30 UTC
Wind	-	060° at 8 knots
Elevation	-	S/L
Temperature	-	30° C
Visibility	-	5 km

The natural light condition at the time of accident was sunlight.

1.8 Aids to Navigation

Brass Terminal Heliport has a NDB station operating on 269 KHz. Identifier "BRS". Normally, the helicopter is navigated with the help of a RACAL RNAV 2 computer using GPS signals for primary navigation, even though the operation is, in principle, carried out in VMC conditions under Visual Flight Rules.

1.9 Communication

There was no formal air traffic control in the area. Nevertheless, flight operations are monitored from a radio room as soon as the aircraft is airborne from the terminal; and for an inbound aircraft, when it gives its ETA. The radio room is located at about 1km away from the Brass terminal harbour.

1.10 Aerodrome Information

There are two concrete made helipads at the Brass Terminal with an elevation of 15ft above sea level. The No.1 helipad, which is 20m x 20m, is used for day light operations while the larger one measuring (25m X 25m), is used for night operations and parking. The Brass Terminal is equipped with such facilities as are necessary for helicopter VFR operations, which are flood light tower, wind-sock and aviation fuel service facility. The crash site is about 60 metres away from these helipads.

1.11 Flight Recorders

The International Civil Aviation Organization (ICAO) in its International Standards and Recommended Practices: Operation of Aircraft - chapter 6 recommends that an aircraft of this type be equipped with a Cockpit Voice Recorder (CVR). In compliance with ICAO recommendation, this aircraft was equipped with a Fairchild model No. A100 and serial numbered 56972, fitted to the aircraft on the 3rd May 2002. It was not mandatory for the aircraft to carry an FDR.

The retrieved CVR was then taken to the facilities of the Bureau d'Enquetes et Analyses pour la securite de l'Aviation Civil (BEA) in France for analysis. During the playback of the CVR, it was discovered that there occurred a sudden stoppage of the tape barely 6 minutes after the No.1 engine start. But the recorder was still serviceable after the accident when inspected at BEA's laboratory in Paris. The G-switch was in the open position, which is why it cut off electric current from the CVR. Please see the CVR readout analysis the tape transcript. – Page 38.

1.12. Wreckage and Impact Information

The main wreckage was situated at the bank of Nembe Creek on the Brass Jetty. The major impact was with the container (caravan) placed on a barge at the Brass Jetty. The main rotor blades were shredded into pieces, as a result of the impact. The tail boom section and the tail rotor assembly were detached from the main fuselage. Also, the vertical stabilizer and the rear-sliding door of the starboard were completely separated from the aircraft. The position of the left rudder pedal was found in the full forward. The No. 1 FCU lever was in the idle position, while the No. 2 FCU lever was forward in emergency range and the gate was in the OPEN position,

1.13 Medical and pathological Information

Four (4) souls (two crew and two passengers) were confirmed dead in the accident, while 8 passengers on board sustained minor or no injury at all. Autopsy report was sought on the crew and from the Coroner's report, the commander died of hemorrhagic shock and intracranial hemorrhage while the co-pilot died as a result of skull fracture with brain damage and intracranial hemorrhage.

The two passengers' autopsy report was not received.

1.14. Fire

There was no fire out break in this accident.

1.15. Survival aspects

The aircraft impacted with a 20-foot steel container located on a barge, which was moored at the riverbank and the impact dealt a devastating blow to both the aircraft and four of its occupants. The aircraft then flipped over into the river and water started to ingress into the cabin. The accident would have been totally survivable, if not for the injuries sustained by the crewmembers from direct impact with the obstacle, especially on the starboard side and the cockpit section, which the deceased's autopsy report described as "multiple fractures and hemorrhaging".

Those who survived the crash did so by the fact that their sitting positions were not substantially affected by the impact. They also survived by the virtue of their swimming capability. The evacuation process was also helpful, in that, the staffs of Agip, who were at the riverbank promptly, rescued those who could not swim. Two left hand seats from the middle row were found completely detached from the floor of the aircraft, but the occupants of those seats survived the crash with minor injuries.

The survivability of this crash was enhanced by the fact that the aircraft crashed into the creek with shallow water level, the accident occurred during a broad day light and at the vicinity of the Brass Terminal, where there were several staffs of Agip, who responded swiftly to the rescue and evacuation needs of the crash victims.

1.16. 0 Tests and Research

After the accident, major susceptible components from the wreckage were inspected locally and then transported to the airframe manufacturer's Customers Support Facility at Marignane, France. Both engines were shipped to the Turbomeca the engine manufacturer's Customer Support Facility at Tarnos, France for detailed stripping, if necessary. The shipped items include:

1. Engine at positions 1 and 2.
2. The two Fuel Control Units (FCU)
3. Tail Rotor Gearbox
4. The right hand front Floatation
5. The G-Switch
6. Tail Rotor Blades
7. The Fenestron Duct
8. The two free-wheel assemblies (LH & RH)
9. One fractured Rotating Scissors-Link Bolt
10. Central Warning System

1.16.1 The Engines

At the initial inspection of the wreckage after the accident, it was unanimously agreed by the participating accident investigators that the two engines be forwarded to TURBOMECA COMPANY, the manufacturer's Customer Support Department at Tarnos, France. So the engines, serial numbered 12134 on position 1 and 12148 on position 2 were air freighted to Tarnos for stripping.

At Tarnos, inspection and testing showed that the two engines were working normally at the time of the first sign of the accident and until the final impact with the container on the barge. Damages were external to the engines and consistent with the type of impact. Most significant observation at the engine facility were that:

(a) - The bleed valve mounting boss on the compressor casing was crushed.

(b) – Misalignment of the drive gear/spline nut positioning marks, which indicates an over torque. The distance between the 2 marks of 1.65mm on engine No. 1. and misalignment of the No.2 marks by 1.40mm.

(c) - Rubbing of the centrifugal compressor found impacted at leading edge.

Tests and inspections result show that all the investigations carried out in the material laboratory showed that failure or damages are resultant of impact from the accident. Both the RH and the LH engine to MGB coupling were delivering equal torque to the main gearbox at the time of the impact. That means there was no pre-impact failure of the engines.

(d) - Deposits of mud (laterite) inside the 2 engines, which was found normal for operation in dusty area.
(e) - The accessory gearbox cover found cracked.
(f) - No.2 starter drive shaft found ruptured (a design provision)
(g) - The 2 FCUs were removed and tested on a test-rig.

It is pertinent to note that both engines were operating, approximately, at the same power output at the moment of the crash. This evidence does not explain the throttles' positions.

1.16.2 The two Fuel Control Units (FCU.)

Immediately after the inspection of the two engines, the fuel control units were removed and tested with FCU test cells at

Turbomeca. The number one FCU was first hooked up to the test rig and the result was that there was P2 air leakage of which did not signify any loss of performance on the fuel output. There was no problem at all on the number 2 FCU when it was test-run on the rig. (Please see Annex 1 for the LH engine and FCU test results).

Despite these results for the two FCUs, it was unanimously decided that number 1 FCU be installed on a life engine for actual performance observation. The performance of this FCU was satisfactory.

1.16.3 The Tail Rotor Gearbox

The tail rotor gearbox was shipped to the aircraft manufacturer but no technical problem was discovered.

1.16.4 The Floatation Gear

AS365N2 is equipped with an emergency floatation gear for over water operations. Four inflatable floats form two assemblies located on either side of the aircraft; each assembly consists of one spherical and one cylindrical floats (Please see appendix 5.4 on page 34). The helicopter is designed to carry the gear in case of emergency landing on water to allow evacuation of passengers. When the helicopter is in-flight, the EMERG FLOAT control switch is selected on the instrument panel to energize the installation (ARM POSITION). There is a percussion control push-button on the instrument panel, protected by a frangible disk with two amber lights, which illuminate when circuits are energized. Another push-button is located on each pilot's collective lever grip and both are in parallel with the percussion control button. To inflate the bags, all that the pilot has to do is depress the button on his collective lever grip, but the control switch on the instrument panel must be in the "ARM" position.

The NEVER exceed speed (V_{NE}) limit for floatation gear armed or inflated is 90knots (166 km/hr).

The floats were inflated in flight. The ARM switch was found in off position, and the 2 switches on the panel were intact. All balloons of the float operated normally.

The operator's floatation gear expert released the following findings:

(h) Continuity and insulation checks on the LH & RH electrical
Power supply lines were found to be OK.

(ii) Floatation trigger relay wiring input and output and their operation were checked OK.

(iii) Both collective float switches were checked and found to be OK.

(iv) The instrument panel float switch was checked and found to be OK.

(v) Float Arming Switch was checked. One contact was in open circuit in the LH. Both in "OFF or in ARM" position and the other switch contact, the RH one was OK. This failure could be attributed to salt water contact, otherwise the system float No. 1 would have been faulted that the No.1 arming light ON.

(vi) AERAZUR's (the floatation gear manufacturer) Finding shows that:

(a.) The upper and lower covers were laced (snap-cord R721A5805 – strength = 25 daN)

(b.) The lacing is not compliant; there is a knot at each eyelet.

(c.) Cutouts have been produced on the protective foam around eyelets.

(d.) The polycarbonate is broken at the edges of the covers subsequent to excessive aging.

1.16.5 The G-Switch

The post crash investigation of the G-switch SP 3810 was carried out on the 4th April; 2003 by the manufacturing company, CROUZET AUTOMATISMES in the presence of the representatives of BEA and EUROCOPTER. The function of the switch is to cut-off the CVR, when the aircraft exceeds 6-G acceleration. On impact, the switch disengages and opens the electrical system. The information recorded on the CVR is thus preserved in the event of a significant impact, or even accident.

Two series of tests were performed. The first test by "vibrating rail" method, the switch was found to be working perfectly well at the prescribed value of 6G acceleration. The second test was by "calibrated hammer". Under this condition, the switch worked with small application of acceleration, which could correspond to

1300 HZ frequency produced by the gas pressure from the gas bottle during the floats' inflation.
But the CROUZET's findings indicated that, "the significant corrosion of the parts explains the operation of the switch after a few maneuvers and its disengagement above the maximum values. The mechanical sub-assembly and the micro-switch operated correctly. The product is not implicated in the accident and in the application in general". Please see annex 4 on page 75.

1.16.6 The Tail Rotor Blade

The 11 tail rotor blades and the whole tail rotor assembly were transported to the facility of the helicopter's manufacturer, Eurocopter in Marignane (France), where first analysis were carried out, particularly on one blade number 35317. It seemed that the different fractures were in static mode.

Incidentally, on the 28th March 2003, a tail rotor incident occurred to another AS365 in Angola. One of the tail rotor blades fractured in flight at cruising speed. Investigation revealed that a fatigue rupture between the Kevlar spar and the joint was the cause of the fracture of the blade.

Corresponding analysis were then performed on the blade number 35317 and the other blades of the AS 365 registered 5N-BBS (see the report on appendix 5.7 on page 36). The inspection analysis then concluded that the blade number 35317 presented a similar fatigue crack in the same area. This fatigue crack involved the rupture of the blade number 35317 then, this blade damaged the adjacent blade (number 36853), which also fractured. These fractures affected all other blades in the tail rotor assembly. It is to be noted that Eurocopter issued an Alert Bulletin No. 05.00.17 on April 16th 2003, to introduce a temporary operating time limit of 160 hours for certain blades P/N 365A112-0020-02 and to increase the maintenance intensity for the blades with these part numbers.

These measures, which were made mandatory by DGAC Telegraphic Airworthiness Directive No. T2003-155(A), lead to suspension of flights for helicopters equipped with, at least one of the concerned blades(similar to blade number 35317) until the replacement of these blades. By the *Information Letter No. 00000137* dated August 5th 2003, Eurocopter decided to remove from service the defined blades. Investigation revealed that a fatigue rupture of the Kevlar spar of a tail rotor blade was the cause of the failure. A corresponding analysis was then performed on the tail rotor blades of 5N-BBS and a similar crack was identified in the same area. This area is located between the Kevlar spar and the polyurethane material at a 90° angle of the tail rotor blade.

1.16.7 Fenestron Duct

The inspection of the fenestron duct indicated that there was no technical failure before impact. All the ruptures were of static failure, which was the direct result of the impact with the container on the barge.

1.16.8 Freewheel Assemblies

The test carried out by Eurocopter showed that both freewheel worked normally.

1.16.9 The fractured Rotating Scissors Bolt.

Metallurgical test performed on the rotating scissors' lower link bolt depicted that the fracture was a static failure meaning that the bolt fractured at the impact of main rotor blades with the container on the barge. No technical problems or deficiencies before impact. Please see the result of metallurgical test performed on the bolt and the spacer of the scissor link assembly. (Annex 5)

1.16.10 The Central Advisory Panel

A section of the instrument panel was forwarded to Bureau d'Enquetes et Analyses pour la Securite de l'Aviation Civil (BEA) - the French Aircraft Accident Investigation Bureau in Paris, requesting that CEPr at Saclay near Paris to perform post impact examination on the instrument panel light bulbs. The caution light, which a survivor had described that a red light was brightly illuminated on the panel was also tested. The result showed that the electric bulb's filament had no major deformation, nor any abnormal elongated spiral elements. A reason for this result could be that the impact of the accident was not severe enough to register any effect on the bulb filaments.

1.17 Organizational and Management Information

Schreiner Aviation Group BV. is the parent company of Aero Contractor Company of Nigeria Ltd. The company is based in the Netherlands, where it operates both passenger and off-shore oil rig support to Shell Oil Company and other off-shore explorations in

Europe. A Schreiner Airways investigator was available to represent the owner in the investigation team.

Aero Contractor Company of Nigeria Ltd. is the operator of this and many other rotary and fixed wing aircraft in Nigeria for many years and has since then been delivering safe and efficient flight operation supports to the Nigerian oil exploration industry. Aero Contractor's aircraft maintenance department is found to be reliable and up to the task for the fleet of the company's aircraft.

CHAPTER TWO

2, Analysis

2.1.1 The aircraft was airborne from Brass Terminal at the time 1325 hours UTC heading towards Port Harcourt Agip Base hanger on the mainland, the commander was on control and the co-pilot was on the communication radio. About 49 seconds after the take off, the co-pilot requested to take over the control and the commander obliged by handing over the control of the aircraft, which was a normal procedure. Barely two minutes and 30 seconds after the pilots exchanged roles, the cockpit voice recorder (CVR) stopped working and AIPB considers this to be the beginning of the accident. Some passengers gave evidence that about six to ten minutes after take-off, they heard a sudden bang noise coming from somewhere in the aircraft. This noise could be associated with the percussion of inflating the float bags.

2.1.2 In the opinion of the BEA and the other investigators, "the CVR stoppage is not the beginning of the accident. It is an incident without any effect with the accident, which is the loss of control of the helicopter on short final"

2.2 The Float Gear Inflation.

2.2.1 The aircraft had just reached its cruising altitude of 700 feet above sea level as this was broadcast to the Area Network Controller and at the attained speed of about 135knots when the float bags suddenly inflated, AIPB believes that no type-rated pilot would, knowingly, deploy the floatation gear at this speed, because, according to the *Aircraft Flight Manual* (AFM), the "never exceed speed" for inflating the floats is 90 knots, which makes the investigating team to consider all possible scenarios for the floats to deploy, whether it was by an intentional command or an involuntary command.

Considering the fact that, if there was no command input from the crew for the float to deploy, the remote possibility remains that, the circuit could be triggered by an outside factor, such as someone using a mobile phone or such as another technical deficiency. Nothing, particularly in the electrical circuit, has been found to suggest a voluntary command event by the crewmembers.

Floatation Gear Test.

- In conclusion of the floatation gear test performed, the result showed that the poor condition of the fabric covers, the container and non-compliance lacing (one knot at each eyelet increases the strength of the snap-release system) had caused the container not to open in a proper way. These defects are due to aging of the parts, which were not replaced at the overhaul period of the float gear. It is apparent that no fault was discovered to indicate any problem, which can be associated with any technical functionality of the float mechanism prior to impact. (Please see annex 3 on page 64)

2.2.2 The BEA and other Investigators hold the belief that:

" We are not completely sure that the helicopter was exactly at 700 ft and 135 knots. Intentional command or an involuntary command is different to circuit activated by an outside factor or a technical deficiency and Float inflation by the crew.

(i) "Circuit activated by an outside factor or a technical deficiency. Considering the fact that, if there was no command input from the crew for the float to deploy, the remote possibility remains that, the circuit could be triggered by an outside factor or by a technical deficiency. However, it is not possible that using a mobile phone could succeed to activate the electrical circuit of the float gear.)

(ii) "Nevertheless, the investigating team believes that this event of the float deployment has no consequences on the capability of the helicopter to fly and to perform a landing at the helipad. The only effect is, perhaps, it could have placed a little stress situation on the crew after the surprise caused by the sudden inflation. But the team believes, this stress has no relationship with the other following events:

(a) *"The float inflation by the crew*

– It seems that, it only could be a pilot error and not a voluntary action. Indeed, it is possible for the crew to push, inadvertently, the float inflation switch on the collective lever, which is not really protected from an accidental action from the crew. In addition, as a matter of fact, there was no reason for the crew to activate the float at that moment of flight mode. Indeed, no type-rated pilot would, knowingly deploy the floatation gear at this speed, because, firstly, the flight was over land and not over the water and,

- "Secondly, the flight was supposed to be in the cruising phase at the cruising speed of 135 knots. Then, according to the ***Aircraft Flight Manual (AFM)*** the never exceed speed for inflating the floats is 90 knots.
- "It is to be noted that the crew should have altered the position of the float control switch on the instrument panel to the "ARM" position in order to be able to activate the floats. Indeed, the switch was found in the "OFF" position after the accident."

2.3 The CVR Stoppage

AIPB believes that the CVR stopped functioning simultaneously with the deployment of the float bags. But all the tests performed on the CVR and its electrical circuit after the accident did not reveal any technical deficiency that could be attributed to the electrical or mechanical system of the cockpit voice tape recorder. During the examination, the mechanical sub assembly and the micro switch of the recorder were correctly operating.

AIPB, however, agrees with the BEA and other investigators that no indication of the gear inflation noise was registered by the CVR, which means that the CVR had stopped at the beginning of the inflation. According to the testimonies it is believed that the CVR stopped functioning simultaneously with the deployment of the float bags but the investigating team considers all possible scenarios for the CVR stoppage:

(i) Technical deficiency

All the tests performed on the CVR and its electrical circuit after the accident did not reveal any technical deficiency that could be attributed to the electrical or mechanical system of the cockpit voice tape recorder. During the examination, the mechanical sub assembly and the microswitch of the recorder were correctly operating.

(ii) G-Switch device

It should be noted that, the CVR is designed to Mechanically stop functioning at a high acceleration of 6-G, which is practically unattainable at, even above the exceeded maximum authorized speed of 90 knots. It is also believed that it is quite impossible for the helicopter to attain such an acceleration that will produce the force of 6-G in flight.

(iii) Particular acceleration which activated the G-Switch

Another designed feature in protecting the unwarranted continuous functioning of the CVR is the G-switch in the electrical circuit. This device should stop the continuous recording of the CVR at a frequency of 1300 Hz, which could be created by the combination of the vibrations generated by the gas pressure of the float bottle attached to the helicopter's structure to where the G-switch was attached and the vibration status of this structure at 135 knots, could have activated the switch, which disengaged and opened the electrical system to the tape recording head.

2.4 The Engines Performance.

AIPB, the BEA and the other investigators, however, agree that the two engines be shipped to the Customer Support Facility of Turbomeca Company in Tarnos, France; for detailed examination. One of the major findings at the facility, was the misalignment of the drive gear/spline nut positioning marks, which is a design to indicate an over torque condition. The engine examination did not reveal any pre-impact malfunction, particularly the misalignment of the drive nut positioning mark, which give an evidence of an over torque. Also, the damages of the MGB coupling and the freewheel, show that the engines were performing normally and at approximately the same power output, when the impact occurred.

2.5 Throttles position:

When the helicopter was inspected after retrieval from the river, the RH throttle was noticed to be in "emergency" position, giving the impression that the crew might have selected it in that position. Careful examination suggested that, after the check at the beginning of the flight, which was performed by the crew, the gate was probably not correctly closed. So, when persons tried to escape from the helicopter after the crash, it is possible that somebody moved the throttle or it could have equally be moved during the wreckage recovery from the water. The LH throttle was in "idle" position, the position that could have also been altered during the emergency escape or wreckage recovery.

2.6 Loss of control of the helicopter:

The investigating team considered 3 factors, which might have caused the probable loss of the helicopter's control by the crew:

(i) Flying error of the crew?
The investigating team found that the approach method used by the crew was a standard part of the flight, which should be without any particular difficulties for a crew with so many flight hours.

(ii) Vortex phenomenon?
This phenomenon could, typically, have occurred because of the tail wind approach and particularly in the short final, as the forward speed was low. But, in this case, the helicopter would have performed a fierce descent without any rotation.

(iii) Fatigue rupture of a tail rotor blade:
Obviously, it was on the flight path, where there were significant stress on the tail rotor blades, because of the heavy load, the tail wind (which is not a normal approach procedure in public transport) and the speed. But the helicopter was within the manufacturer performances. The fatigue rupture of one of the tail rotor blades, which caused severe damage to the other blades and the loss of effectiveness of the tail rotor in the final approach and consequently, causing the loss of control of the helicopter by the crew.

2.7 <u>The Scenario of the accident</u>

Firstly, one of the crewmembers, inadvertently, pressed on the float inflation button on the collective pitch, which occurred about 6 minutes after engine start, i.e. about 3 minutes after getting airborne from Brass. At this time some passengers confirmed hearing a sudden bang noise.

Secondly, almost simultaneously with the beginning of the float inflation, a particular unsubstantiated vibration caused the activation on the G-switch, which consequently, stopped the CVR from working. It's quite sure that the float inflation at such a speed might have disturbed the dynamic airflow around the helicopter, which started rolling, yawing and dropping until the speed decreased. The passengers perfectly described that situation too.

After several moments, the crew regained control of the helicopter, and the passengers confirmed this, by stating that the co-pilot turned his head to them saying everything was OK and that they were flying back to Brass.

The AIPB is of the opinion that, if the co-pilot could turn his head towards the cabin to address the passengers, this situation informed that the commander had taken over the control. This indicated that there had been an initial controllability problem and the emergency crew never really could tell what would happen next after the initial shock and the MAYDAY radio transmission. After these moments of apprehension and trepidation, AIPB believes that the crew were not in total control of ANY situation and this is the main reason why the helicopter should have been, immediately, put down at any appropriately chosen area and not necessarily at the company's helipad. The emergency broadcast indicated that the surprise float deployment had seriously affected the crew, at least initially, and finally, the aerodynamic and controllability of the helicopter would become unpredictable to the crew. It had been vindicated that the pilots' explicit "Mayday.... " confirmed their initial shock and difficulties. It looked like the commander did not consider the imposed danger that could occur to the lives on board and that he should act on the side of caution rather than hoping that the aircraft must get on to the helipad.

But the commander still continued to press on, irrespective of the consequences of operating the helicopter in an unpredictable aerodynamic environment with the floats deployed, especially when the aircraft manufacturer has no specific and clear-cut instructions concerning continuous flight operation with the floats fully deployed. This is like flying against unknown odds, as any aviator would rightly know that disturbed aerodynamic flow over and around an airfoil is critical to the sustenance of any aircraft in flight.

The float occurrence would have been cited as an incident, if the aircraft had been ditched immediately in accordance with over water emergency operation. The decision of not landing or ditching the aircraft immediately is the beginning of the accident and this is where the AIPB holds a discrete opinion from the other *investigators' about "for several ensuing minutes, the crew was in total control of the helicopter". AIPB holds the conviction that the INITIAL RESPONSE, as indicated by the Mayday call, was a serious and control-affecting emergency and was an initially correct judgment, albeit coming from the co-pilot.*

But, in the opinion of the other investigators, the decision of the commander to continue the flight with the float inflated to Brass Heliport was correct, because the helicopter could fly 'normally' and therefore, there was no urgency to ditch. Another argument, which was cited for the continuation of the flight, was that there was neither a manufacturer's instruction nor an operator's procedure that would have forced the aircraft to ditch on the water.

We, in the AIPB believe that, from the Co-pilot's radio communication with the company's nearest assisting helicopter - 5N-ESO, which intercepted the MAY DAY alert; the Co-pilot, if he were to be in command, would have settled the helicopter on the river, because he had broadcast "ESO, please look for us on the river". To him, the copilot, to ditch would be the most appropriate and logical precautionary procedure to perform and not to display a show of courageous airmanship. We believe that the crew should have thought of the unknown aerodynamic consequences and performed the alternate (since there was no guidance provided by the aircraft manufacturer). But the supremacy of the commander retorted, in a calm voice, "I'm trying to make it to the helipad". This was autocracy in a democratic cockpit.

As the helicopter 5N-BBS was performing a final approach and, particularly, in the short final, the investigating team asserts that, one of the tail rotor blades is believed to have fractured, thereby causing serious damages to the other blades and, consequently, causing the loss of effectiveness of the tail rotor control. The helicopter then became uncontrollable and impacted with the container on the barge.

It is clearly the last section of the flight path, says the team, where there were significant stresses on the tail rotor blades due to the heavy load, the speed and also the tail wind that affected the helicopter. However, the investigating team believes that, the helicopter was within the manufacturer's performance specification. The team also believes that, it is to be noted that the first event of the float inflation could have placed the crew in a little stressful situation. But, this stress has no relation with the real cause of the accident.

2.8 The AIPB's Final Comment.

Whether to ditch or to continue to the helipad, the decision of the senior pilot-in-command must, of course, take precedence over that of the other pilot's suggestion. The co-pilot had even broadcast that the searching helicopter should "look for us on the river". For him, he would have ditched the helicopter on water, but the commanding officer had ruled that they must continue flight to the normal helipad at Brass Terminal without giving due consideration to the constituted drag effect by the deployed float-bags in spite of the aerodynamic uncertainties/probabilities that may affect continuous flight under the existing condition. Leadership involves teamwork and good quality of a leader depends on the success of leader's relationship with the team. This, to AIPB is the "Human Factor" in the accident.

AIPB will like to take into consideration a near similar incident, which once led to disciplinary action against the Commander. His authority of command was once suspended sometime in the past, for a similar unacceptable operational decision-making, when he was on a special official mission outside his base. It looks like the Commander's habit of continuing with a mission, 'come what, what may', could not be broken in spite of recurrent training and other disciplinary actions against him. From that experience, it seems that the commander had penchant for taking chances and unnecessary risks.

For instance, on the 7th December 1999, while on detachment of special duty to Abuja, the commander, whilst ground-taxing the helicopter, caused the port main undercarriage wheel to collide with a taxiway lamp, resulting in terminal structural damage to the wheel. After when the Co-pilot reported to him that the wheel was no longer free to rotate; the captain resulted to air-taxing the helicopter back to the starting point and called for engineering evaluation by the detachment engineer. The Maintenance Engineer confirmed that the inner rim of the port main undercarriage wheel had cracked and that the damage had caused the brake assembly to prevent the wheel from rotating. Despite the engineer's report, the commander still continued with the mission. The commander was found culpable by his company management on four grounds, the most serious of which *was "Your action in continuing with the mission following the incident contravenes:*

(j) the Federal Republic of Nigeria Civil Aviation Act – Commencement Order and Regulations 1966,

(ii) the Company Basic Operation Manual and

(iii) the approved Minimum Equipment List, all which you are required to be familiar" with.

After reviewing the incident, the company management mete out six disciplinary actions on the commander, one of which was "Whilst you will retain the rank of captain for the time being, you may not operate as the commander of any of the company's helicopters until further notice. With immediate effect, you will relinquish your status as a Senior Pilot and your duties as Flight Safety Officer. Your salary will be adjusted accordingly". His command was, later on, restored at a distant date after the pilot had, fully, complied with the recommended disciplinary actions and trainings. The AIPB, certainly regrets that, unfortunately this time around, there was no room for another cautionary admonition.

The phenomenon of continuing a helicopter flight with the 4 floats fully deployed is only one of its kind, especially, when the manufacturer has neither advised in favour nor against continued flight. We, in the AIPB, believe that the crew should have thought of the unknown aerodynamic consequences and performed the alternative by ditching on water or any other closely available open field or waterside bank rather than, willing-lily, continuing to the heliport. The sole purpose of the design of floatation gear is to make an emergency ditch over water, then why not take the full advantage of the already deployed floats and land on the river?

The singularly one-man decisions, which often take place in cockpits, Nigeria's not being exceptional, has manifested itself in this accident. The over bearing commanders' decisions often resulted in serious incidents or accidents. Some commanders always overrule and not merely rule the cockpits. Therefore, AIPB will like to recommend that; Cockpit Resource Management (CRM) topics should always be a part requirement in the Nigerian Pilot recurrent training program for all operators.

CHAPTER THREE
CONCLUSIONS

3.1.0 Findings.

3.1.1 The AS-365-N2 Dauphin Helicopter was manufactured in June 1993 by Eurocopter Company in France and came onto the Nigerian register on the 13th July 2000 at the airframe time of 3,983 hours and 3,366 cycles (landings).

3.1.2 The helicopter's "Certificate of Airworthiness" was valid until 19th June 2003, but crashed on the 3rd of January 2003 at the airframe time of 6,321hours and 3,987 landings.

3.1.3 Schreiner Aviation Group BV of Netherlands owned the aircraft, which was operated in Nigeria by Aero contractors Company of Nigeria Limited, the latter company being a subsidiary of the former in Nigeria.

3.1.4 All documents and maintenance records depict that the aircraft was well maintained by the operator since its arrival on the Nigerian register about 2½ years earlier.

3.1.5 There was no known technical problem with the aircraft at the beginning of the day's flight that morning. First sector Port Harcourt to Bintang Kalimantan (BK) flight was normal, so also was BK to Brass Oil Terminal sector.

3.1.6 The aircraft took off from Brass Terminal at 1324 hours heading for Port Harcourt and the Commander was on the control, which was handed over to the copilot at the time 1328.04hours.

3.1.7 It was about six minutes after engine start that the surviving passengers said they heard a loud bang above engine sound and experienced rocking and rapid descent of the aircraft.

3.1.8 One of the floatation gear 'switch' was involuntarily activated by the crew at the then cruising speed.

3.1.9 The cockpit voice recorder stopped functioning simultaneously at about this time. The CVR had functioned for 3 minutes after take off.

3.1.10 The crew had stabilized the aircraft and started to turn it around back to Brass Terminal.

3.1.11 An emergency radio transmission was made by the BBS Copilot for a search party to look for BBS in the river. But the Pilot-In-Command interjected that he would make it to the helipad.

3.1.12 An eyewitness standing on the quay saw the BBS approaching the harbour in a sideways attitude with the floats deployed and thought they were jerry-cans attached to the side of the helicopter.

3.1.13 AERAZUR, the floatation gear manufacturer detected that the lower fabric cover was still attached to the upper fabric cover, due to the poor condition of the fabric cover and non-compliance with the lacing procedure.

3.1.14 CROUZET, the G-switch manufacturer determined that the product operated correctly. However, further investigations performed by Eurocopter revealed the possibility of G-switch's activation at about 1300HZ. Therefore. Only a frequency of 1300HZ could have activated the G-switch which stopped the CVR.

3.1.15 TURBOMECA. The engine manufacturer's partial disassembly of the engines and the isolation of the two-fuel control unit (FCU) showed that both engines were delivering, approximately, the same amount of torque during impact. According to the engines analysis, which was carried out by the engine manufacturer at Tarnos, both engines were performing normally at the time of the impact,

3.1.16 After the wreckage was recovered from water, the RH throttle was observed in the emergency range position and the LH throttle was found in the idle position.

3.1.17 At EUROCOPTER, the aircraft manufacturer, confirmed that the damage found on the scissor link bolt and spacer were consistence with the type of impact, therefore the bolt did not fail prior to impact.

3.1.18 The French Air Accident Investigation Bureau (BEA) had determined that the CVR was still serviceable in the laboratory after the accident, but the switch was found in open position, cutting power supply to the recorder.

3.1.19 When the helicopter approached over the river near Brass Terminal, passengers claimed that another bang noise was heard and the helicopter spun around, became uncontrollable until it collided with the metal container on the barge.

3.1.20 The Commander was instantly mortally injured, while the Co-pilot died in the NAOC clinic a couple of hours later that day. Two of the passengers were recovered dead from the wreckage.

3.1.21 Detailed inspection of the tail rotor blades showed that one blade (No. 35317) presented a fatigue rupture between the Kevlar spar and the joint. Then this blade broke, causing a static rupture. This static rupture caused the failure of the other blades and the loss of the tail rotor efficiency, which consequently caused the loss of control of the helicopter by the crew.

3.1.22 Findings show that the floats inflation did not result from technical problem, but it occurred owing to an involuntary action of the crew.

3.1.23 The inspection and analysis carried out on the free wheel showed that the power was approximately the same for the two engines.

3.1.24 Metallurgical analysis carried out by Eurocopter Company France, on the Rotating Scissors bolt also shows that the damage found is consistence with the type of the impact suffered by the aircraft. The failure of the bolt and the spacer are of static nature.

3.1.25 The crew inadvertently activated the float inflation. The float activation, supposedly also, caused the CVR to stop functioning.

3.1.26 There was a poor Cockpit Resource Management (CRM.) within this crew

3.2.0 The Probable cause of accident.

3.2.1 The probable cause of the accident is due to the fatigue of one of the tail rotor blades, which caused severe damage to the other blades and loss of efficiency of the tail rotor on the final approach and consequently caused the loss of control of the helicopter to safe landing by the crew.

3.2.2 The first contributive factor to the accident is the incident of the floats' inflation, which was inadvertently activated by the crew. The float activation also caused the CVR to stop functioning.

(Please see BEA's disagreement on page 117)

3.2.3 The second contributive factor is the decision of the commander to continue with the mission and not to immediately ditch the helicopter with a serious controllability problem affecting emergency after the undesirable deployment of the floatation gear.

(Please see BEA's disagreement on page 118)

CHAPTER FOUR

4.0 Recommendations.

4.1 The Nigerian Aircraft Accident Investigation and Prevention Bureau (AAIPB) will like to recommend, through the Nigerian Civil Aviation Authority (NCAA) that the French DGCA– Civil Aviation Director General for the helicopter's manufacturer to modify the tail rotor blades to prevent failures or ruptures of the blades in flight

4.2 AIPB will like to recommend that, through the NCAA, the French DGCA, for the manufacturer to redesign a system to prevent the inadvertent float inflation above the speed of 90knots.

4.3 **AAIPB will like to recommend, through the NCAA that the** French DGCA –

(i) Should make the manufacturer of the aircraft to re-define maintenance schedule for the G-switch to prevent deficiency due to corrosion.

(ii) Consider to the manufacturer to study and evaluate relocation of the G-switch in order to be not activated by low frequencies.

4.4 AIPB will like to recommend to the Nigerian Civil Aviation Authority (NCAA) to ensure that the aircraft type operators in Nigeria should check all floatation gear and apply adequate maintenance to the type of floatation gear installed on the Nigerian registered aircraft.

4.5 Though this type of accident does not occur very often, AIPB still finds it necessary to recommend that the operator should devise a method of protecting the collective lever grip 'float switch' by providing a fool-proof fusible wire guard; or a protective cover plate such that the switch would not be inadvertently tampered with.

4.6 AIPB also recommends that the NCAA ensure that, the Aero Contractors Company Nigeria Limited and, in fact, all Nigerian operators in general, re-evaluate the effectiveness of its Cockpit Resources Management (CRM) training and the CRM qualifications.

4.7 AIPB will, finally, like to recommend, through the NCAA, that the French DGCA see that the helicopter manufacturer give a definitive instruction or instructions in the *Aircraft Flight Manual* and the *Aircraft Check-list* on how should the crew of helicopters handle sudden or inadvertent float deployment in flight. Land immediately or continue to the next heliport?

CHAPTER FIVE

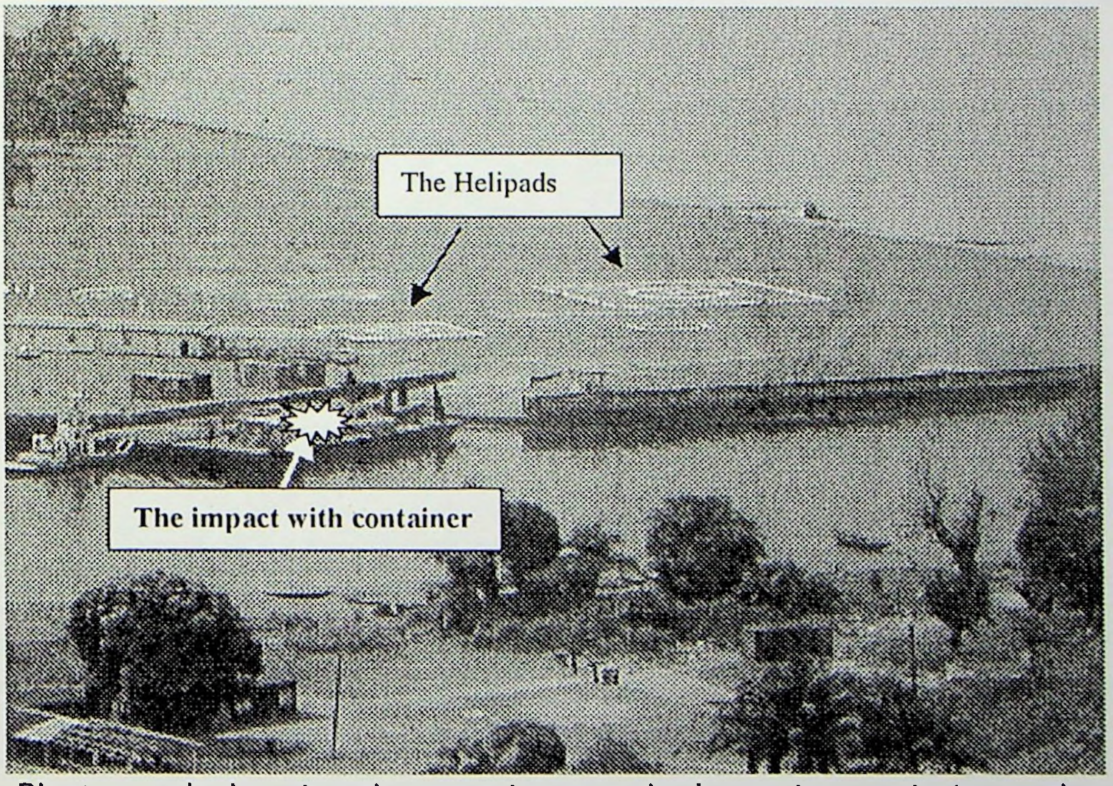
5.0 The Appendices.

Appendix 5.1	-	Nigeria Agip Oil Company (NAOC) Brass Terminal.
Appendix 5.2	-	Accident site showing show the proximity of Helipads to the harbour.
Appendix 5.3	-	The close-up picture of the metal container.
Appendix 5.4	-	5N-BBS after retrieval from the river.
Appendix 5.5	-	Extent of destruction to the main rotor blades after the impact.
Appendix 5.6	-	The Tail Rotor Assembly Inspection After The Accident.
Appendix 5.7	-	Individual Tail Rotor Blade Inspection.
Appendix 5.8	-	The CVU readout analysis and the tape transcript were expertly processed through the kind assistance of the French Accident Investigation Bureau (BEA).

APPENDIX 5.1

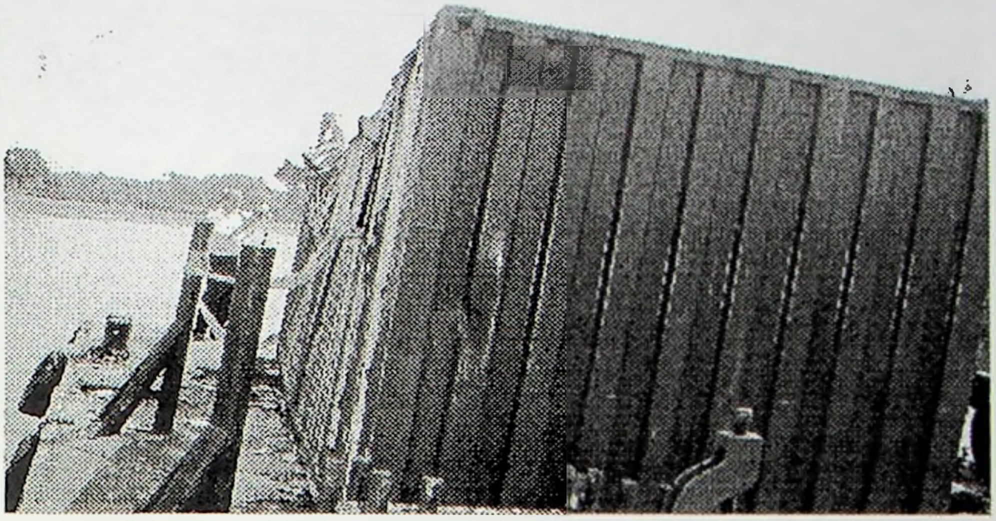
Nigeria Agip Oil Company's (NAOC) Brass Terminal.

APPENDIX 5.2



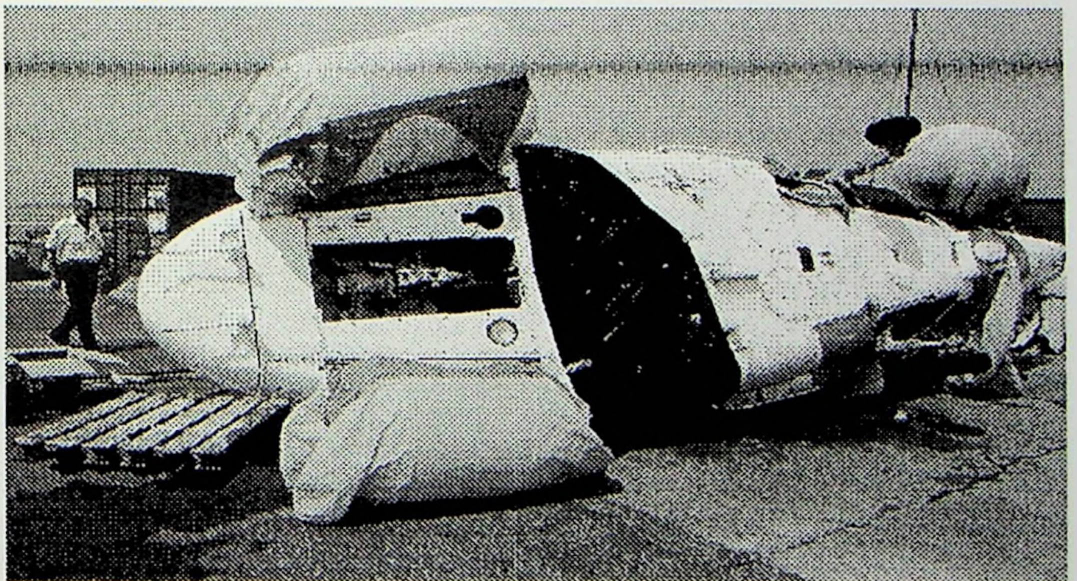
Photograph showing the container on the barge in proximity to the helipads. The helicopter, obviously uncontrollable, strayed to the Barge and collided with the container.

APPENDIX 5.3



Close-up photograph of the container.

APPENDIX 5.4

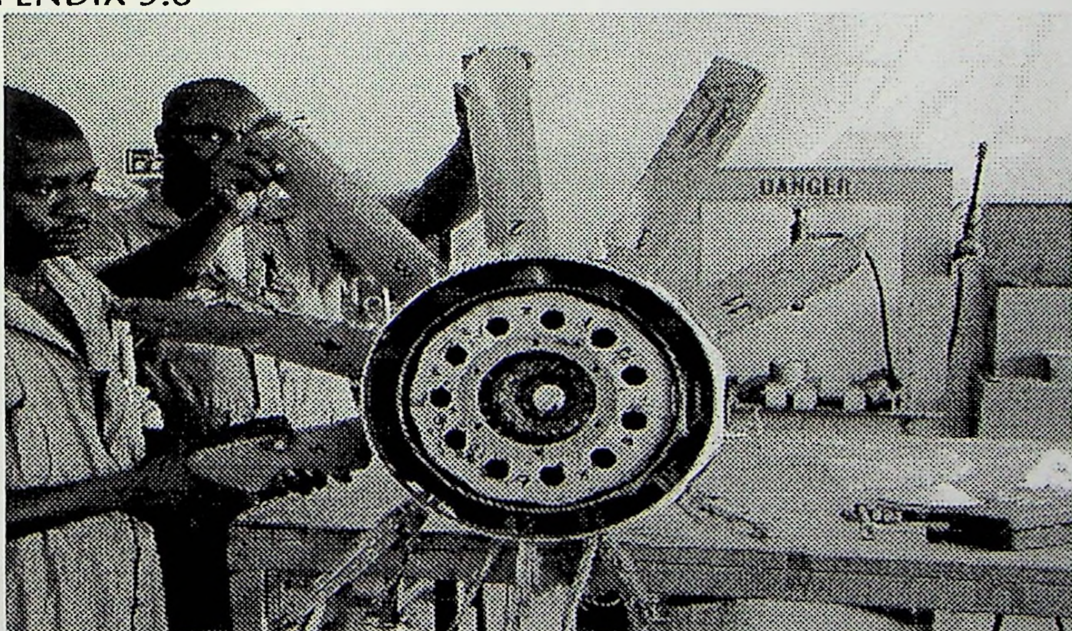


5N-BBS after the wreckage was retrieved from the water showing
3 of the 4 emergency float bags remained still inflated after impact.

APPENDIX 5.5

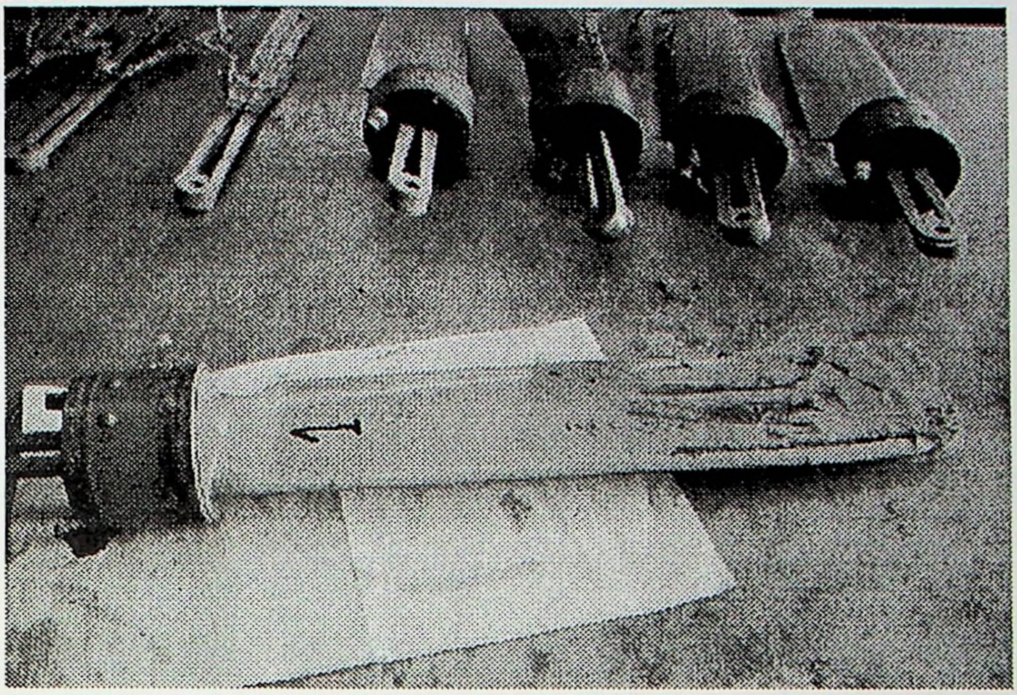
The devastating destruction of the Main Rotor Blades portrays the closeness of the helicopter to the container on the barge.

APPENDIX 5.6



The Tail Rotor Assembly Inspection After The Accident.

APPENDIX 5.7



The Preliminary Individual Tail Rotor Blade Inspection On Site before shipment to the aircraft manufacturer in France.

Appendix 5.8

THE COCKPIT VOICE RECORDER (CVR) READOUT AND THE TRANSCRIPT

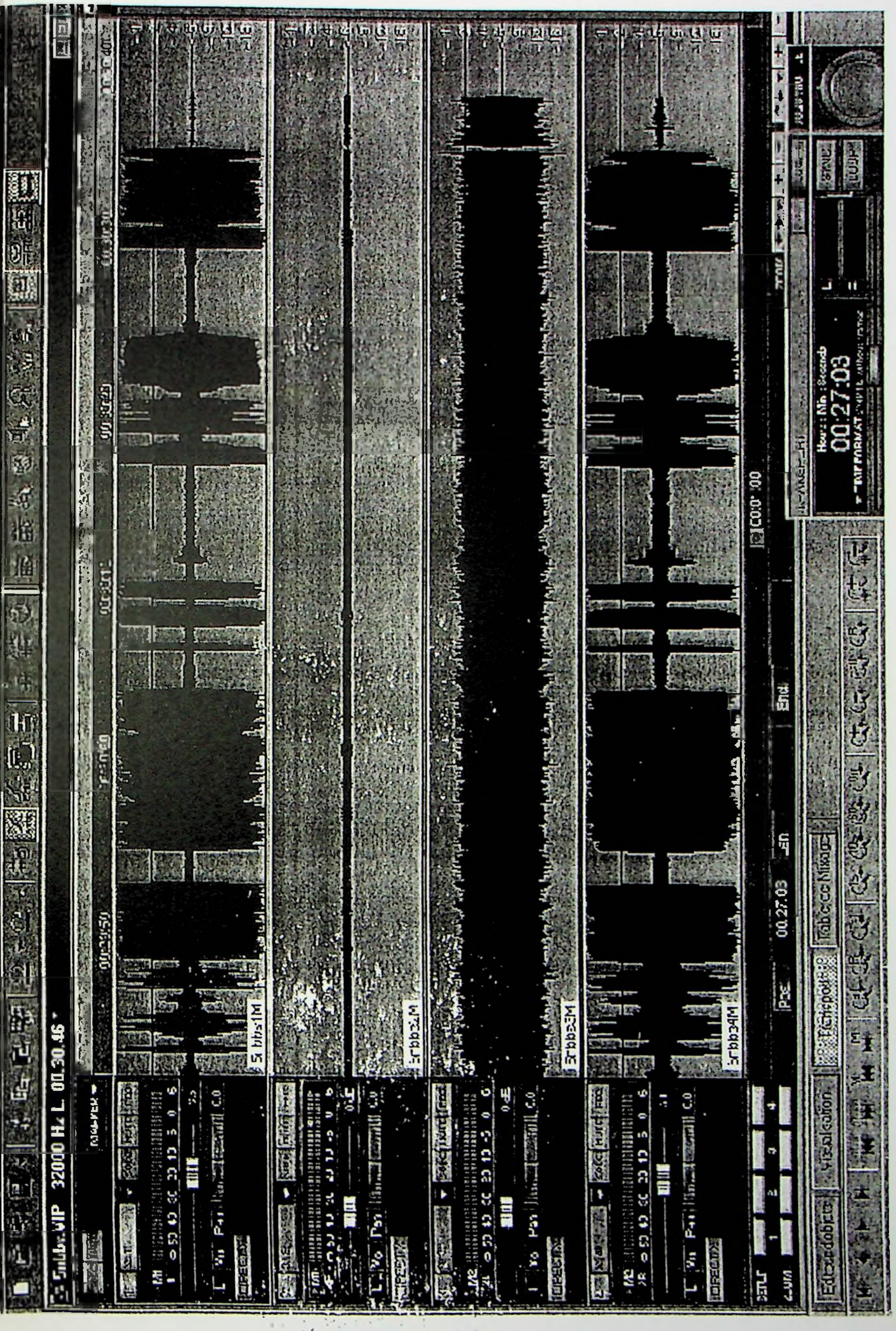
PROCESSED

THROUGH THE AUSPECIES OF THE FRENCH BEA.

BEA

Accident
occurred on January 3, 2003,
on Brass (Nigeria)
to the AS-365
registered 5N-BBS
operated by Aero Contractor

FLIGHT RECORDER REPORT



1. CIRCUMSTANCES

On the January 3rd, 2003 a AS-365 operated by Aero Contractor and registered 5N-BBS crashed during the flight from Brass to Port-Harcourt, Nigeria.

II. RECORDER

The helicopter was equipped with one light recorder: The Cockpit Voice Recorder

	CVR
Model	Fairchild A100A
Part number (P/N)	93-A100-83
Serial number (S/N)	56972

A Nigerian accident investigator brought the recorder back from Nigeria to BEA's Technical Department on January 15, 2003.

III. CVR Read-OUT

The extraction and the replay of the CVR tape was performed on January 15, 2003.

III.1 Tape Extraction

The CVR was found on the water but was transported to BEA in a board outside the water. The CVR was in good condition. During the opening, we found some water inside the protecting block. When the tape was removed, it was possible to clean and dry it. After the extraction, the tape was transferred to a standard empty wheel.

The whole operation was recorded on video.

III.2 Tape replay

The Fairchild A 100 CVR magnetic tape has four tracks which correspond to four channels recorded during 30 minutes.

The replay of the tape was performed on a special REVOX player, adapted with heads of A-100 CVR. During the replay, a copy of the recording was made in "wav" format on a computer equipped with a signal processing software (Samplitude). A visualization of the audio signal on the four tracks is presented in Annex 1.

Channel 1 is VHF communications, warnings, intra-cockpit communications (captain side)

Channel 2 is Public Address not used in this case

Channel 3 is the Cockpit Area Microphone recording (First-Officer side)

Channel 4 is VHF communications, warnings, intra-cockpit communications

Two copies were burnt on labeled CD, one kept in the safe of the BEA and one given to the investigator from Nigeria.

III.3 Recording analysis

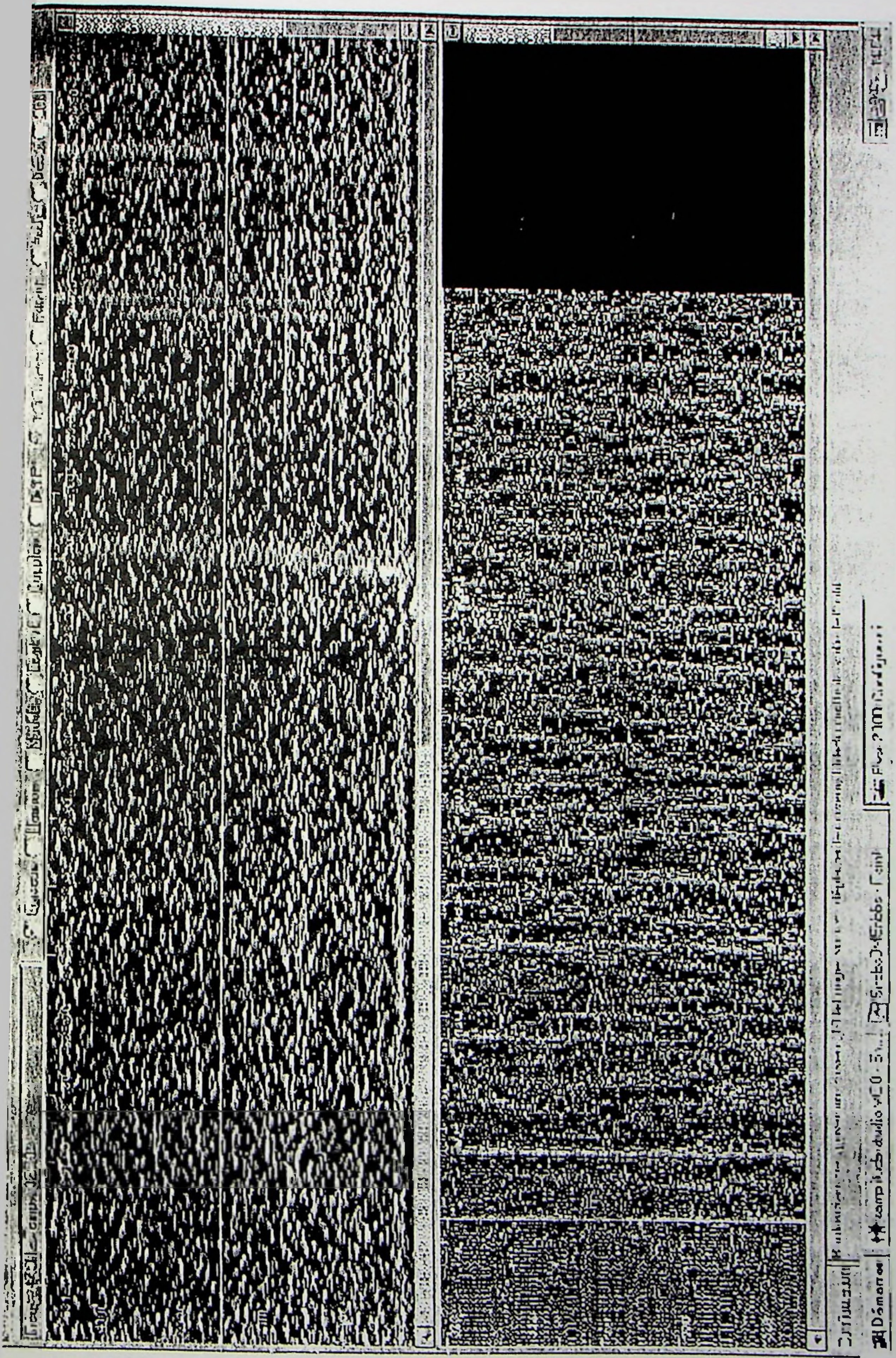
The analysis of the recording began on the same day. A transcript of the flight was made with a read out time (Annex 3). This transcript reports intra cockpit communications between the crewmembers, air work communications, sound from the CAM. Only six minutes and eighteen seconds are recorded on the flight. During normal conversation the CVR stopped. The first spectral analysis shows a rotor turning a 355-RPM without any variation until the end of the CVR (Annex 2). Right now there is no explanation about the sudden stop of the CVR. The accident event is not recorded.

List of the Appendices

ANNEXE 1: Audio signal visualization

ANNEXE 2: CVR spectral analysis

ANNEXE 3: CVR transcript



Aero Contractors AS – 365 Accident in Brass on January 3rd, 2003
Transcript on January 15th 2003

Read – out Time	Captain	First Officer	CAM (PNC, Noise	HF,VHF	Remarks
24 min 18 (0 min 00)					Engine start
25 min 13 (0 min 55)					From IDLE to FLY
25 min 36 (1 min 18)					
25 min 42 (1 min 24)					Inverter/pump?
25 min 43 (1 min 25)					Beep
25 min 46 (1 min 28)					Beep
25 min 52 (1 min 49)					Beep, Beep
26 min 07 (1 min 49)		T,s and P,s Confirm right horizon and loadmeter			
26 min 17					Second engine

Aero Contractors AS-365 Accident in Brass on January 3^{rd}, 2003
Transcript on January 15^{th} 2003

Read-out Time	Captain	First Officer	CAM (ONC, Noise	HF, VHF Noise	Remarks
24 min 18 (o min 00)					Engine start
25 min 13 (0 min 55)					From IDLE to FLY
25 min 36 (1 min 18)					
25 min 42 (1 min 24)					Inverter/pump
25 min 43 (1 min 25)					Beep
25 min 46 (1 min 28)					Beep
25 min 52 (1 min 34					Beep, beep
26 min 07 (1min 49)		T,s and P,s Confirm right horizon and loadmeter			
26 min 17					Second engine

Aero Contractors AS – 365 Accident in Brass on January 3rd, 2003
Transcript on January 15th 2003

Read-out Time	Captain	First Officer	CAM (PNC, Noise)	HF, VHF	Remarks
(1 min 59)					
26 min 55 (2 min 37)		Fully forward Ng. T,s and P,s Capsions? Lights Horizon			
27 min 02 (2 min 44)					Sound
27 min 13 (2 min 55)		All stations 131,8 BBS lifting from Brass 700 ft to ABU….Abnnema call air borne			
27 min 29 (3 min 19)		Oh, minus 3 point 5, eh? Attitude?			
27 min 37 (3 min 19)		…………….. ………………			
27 min 43		Speed alive			

Aero Contractors AS – 365 Accident in Brass on January 3rd, 2003
Transcript on January 15th 2003

Read-out Time	Captain	First Officer	CAM (PNC,Noise)	HF, VHF	Remarks
(3 min 25)		Over the water. Landing gear up			
27 min 49 (3 min 31)					"Undercarriage" warning system call
27 min 50 (3 min 32)		Yes, I know, I have done it myself			
27 min 53 (3 min 35)		You have the mast in sight?			
28 min 56 (3min 38)	Yeh				
27 min 57 (3 min 39)		OK, VY rotate, After take off checks			
28 min 02 (3 min 44)		You have done the take off, can I have it?			
28 min 04 (3 min 46)		THANK YOU			
28 min 06 (3 min 48)		Thank you			

Aero Contractors AS-365 Accident in Brass on January 3rd, 2003 Transcript on January 15th 2003

Read-out Time	Captain	First Officer	CAM (PNC, Noise)	HF, VHF	Remarks
28 min 22 (4 min 04)				Airwork Port Harcourt, 5N-ESO	
28 min 27 (4 min 09)				Yeh, we are coming back from the Agbara platform, two five zero zero feet, for Abonnema zone 41, AGIP Base will be 49.	
28 min 40 (4 min 22)		…………… …………. Stop it here		I have nine souls on board, one hour and…………..	
28 min 53 (4 min 35)				OK, relax, let me say it all over again, from Agbara two five zero zero feet, Abonnema 41 Eh and eh…	
29 min 04 (4 min 46)		………….		Standby, Standby, I'll call you back. Standby	
29 min 12		………….			

Aero Contractors AS-365 Accident in Brass on January 3rd, 2003
Transcript on January 15th 2003

Read-out Time	Captain	First Officer	CAM PNC,Noise	HF, VHF	Remarks
(4 min 54)					
29 min 13 (4 min 55)		390			
29 min 23 (5 min 05)	Airwork the 5N-BBS				
29 min 28 (5 min 10)	....				
29 min 35 (5 min 17)		I did not put the date(?) Ja....sorry put at one five			
29 min 39 (5 min 21)	How much fuel did we take?				
29 min 40 (5 min 22)		We did not take any			
29 min 41 (5 min 23)	Oh				

Aero Contractors AS-363 Accident in Brass on January 3rd, 2003
Transcript on January 15th 2003

Read-out Time	Captain	First Officer	CAM (PNC,Noise)	HF,VHF	Remarks
29 min 43		We took it from Port Harcourt, OK?			
(5 min 25)					
29 min 46	Yah				
(5 min 28)					
29 min 47		Put it			
(5 min 29)					
29 min 48	One second				
(5 min 30)		Thirteen…Eh………			
29 min 51				Airwork,the B..5N-ESO	
(5 min 33)					
29 min 56				OK, we are from Agbara two five zero zero feet	
(5 min 38)				Abbonema zone 39, AGIP base 44, with 9 souls, I hour departure........	
30 min 08					Sound
(5 min 50)					....
30 min 09					....
(5 min 51)					
30 min 11					
30 min 13					

(5 min 53)					
30 min 13					Sound
(5 min 55)					
30 mln 18		Now, are we?			
(6 min00)		We are doing the same..... three-OK-three seven			
30 min 22		Airwork ... the 5N-BBS			
(6 min 04)					
30 min 31		Airwork the 5NBBS Brass 700 ft Abonnenma Z...			
(6 min 13)					
30 min 36					End of recording
(6 min 18)					

THE ANNEXES

The Annexes

Annex 1	-	The technical report on the No. 1 engine and its corresponding FCU component issued by Turbomeca (SNECMA) Group.
Annex 2	-	The technical report on the No. 2 engine and its corresponding FCU component issued by Turbomeca (SNECMA) Group.
Annex 3	-	The technical examination report on the floatation Gear as issued by the gear manufacturer - AERAZUR
Annex 4	-	The result of the examination of the G-switch produced by CROUZET Automatismes the manufacturer.
Annex 5	-	The result of the metallurgical test performed on the scissors link bolt 365a31-1175-21 and its spacer Part Number 704a33-698-023.
Annex 6	-	The emanating ***Service Bulletin*** out of the investigation of the tail rotor blade failure.

ANNEX 1

THE TECHNICAL REPORT ON THE ENGINE No 1
Serial Number 12134

AND

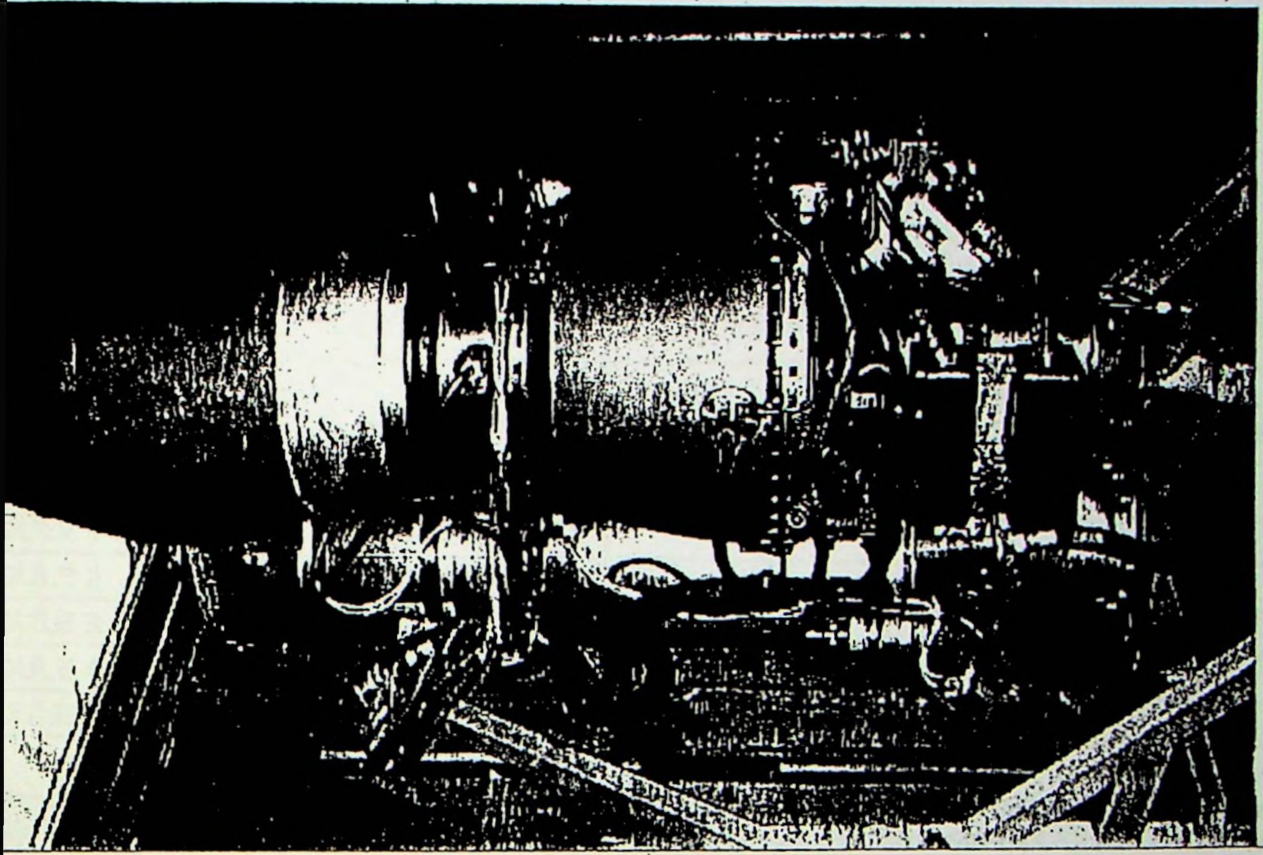
ITS CORRESPONDING FUEL CONTROL UNIT (FCU)

BY

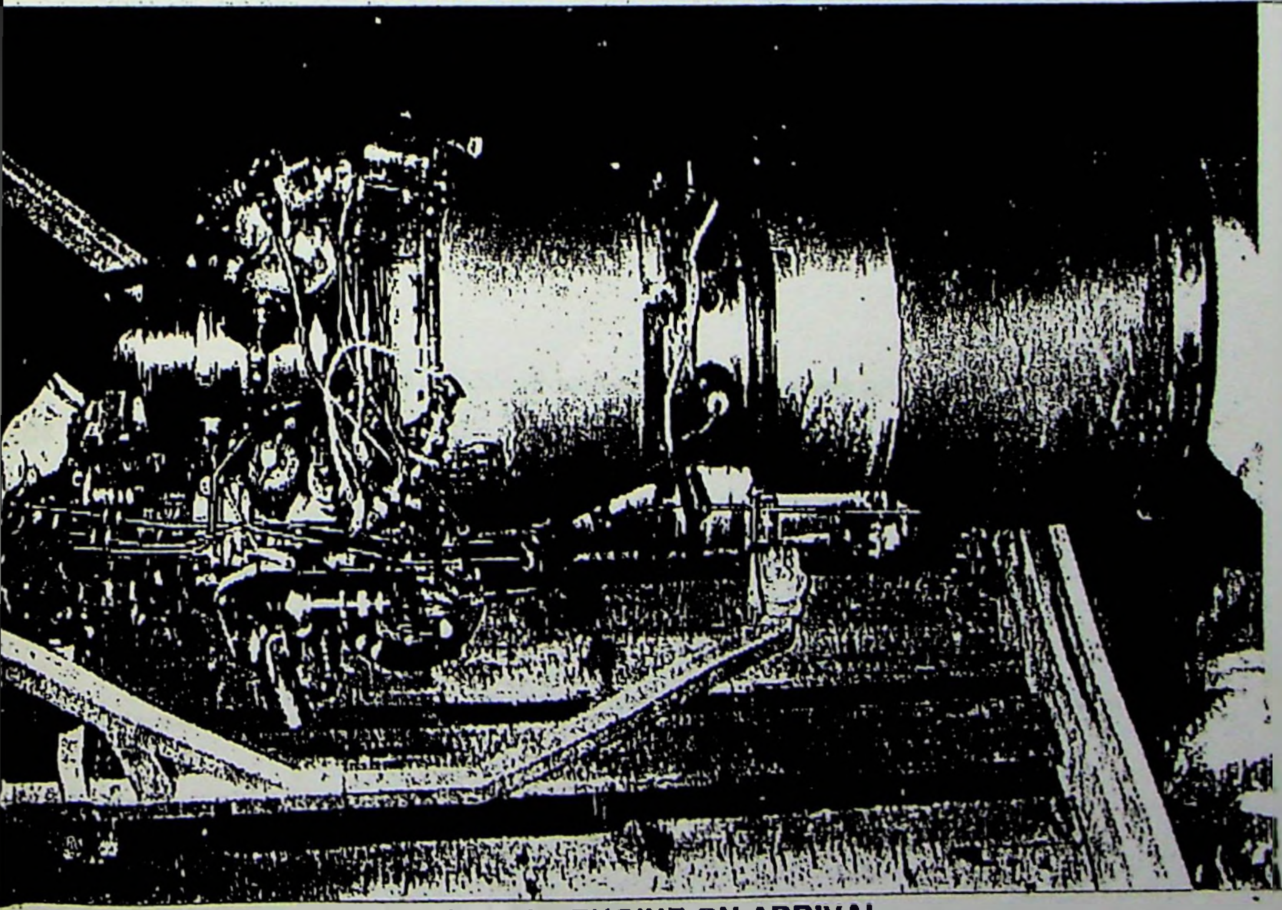
TURBOMECA SNECMA GROUP
CUSTOMER SUPPORT DEPARTMENT
40220 TARNOS, FRANCE

Turbomeca
groupe snecma

TECHNICAL REPORT N° T03 / CR147A



PICTURE 3 – ENGINE ON ARRIVAL



PICTURE 4 – ENGINE ON ARRIVAL

Turbomeca
groupe snecma

40220 TARNOS
stomer Support Department

TECHNICAL REPORT N° T03 / CR147A

Commercial File N° : WU541

NT :	ARRIEL 1C2	S/N :	12134
OR :	SCHREINER NIGERIA	Date of equipment arrival :	Feb. 10th ,03

/ MODULE / ESSORY	S/N	WORK PERFORMED	TOTAL HOURS	TOTAL CYCLES	HOURS SINCE OH	CYCLES SINCE OH
NGINE	12134	INSPECTION	3740	5116	2461	3619
DULE 1	12135	INSPECTION				
DULE 2	12135	INSPECTION				
DULE 3	12135	INSPECTION				
DULE 4	09424	INSPECTION				
DULE 5	12135	INSPECTION				

l investigation was attended in Turbomeca Tarnos workshop on February 12, 2003, in the presence imini (Accident Investigation and Prevention Bureau, Nigeria), Mr. Mauviot (BEA), Mr. Van Der SCHREINER), Mr. Nicolas (Eurocopter), and Turbomeca's representatives.

report N° 03/001

ASON FOR EQUIPMENT RETURN

st-accident investigation

ONCLUSION

mplete dismantling of the engine exhibited several damages (see page 2 for details). All arings were found seized by corrosion.

Engine and accessories will be modified in accordance with our Quality Assurance Department requirements (see modifications to be embodied)

ures :	O.PEYRE	T.DUPUY
	[signature]	PO [signature] Date : May 14, 2003

Turbomeca
groupe snecma

TECHNICAL REPORT N° T03 / CR147A

FINDINGS ON ARRIVAL:

- Engine received in a sealed container (pictures 1, 2, 3 and 4).
- Bleed valve in open position.
- Gas generator and free turbine rotating assemblies found seized.
- Harness sheaths found heated on front part : picture 8.
- Accessories found distorted : HE connector, start drain valve, TU208 cable supporting bracket, axial compressor casing flange.
- Exhaust pipe distorted.
- Front support distorted.
- Axial compressor impacted.

FINDINGS ON TEST RIG BEFORE DISASSEMBLY:

No tests performed before the disassembly.

FINDINGS AFTER DISASSEMBLY:

- Presence of a particle on module 5 magnetic plug (no particle found either on magnetic plugs or into the oil filter) : picture 5.
- Significant rubbing between helicopter's flector and front support : pictures 6 and 7.
- Impacts at the level of the HE box, on start injector side.
- Axial compressor blades eroded over 2 mm. Slight signs of rubbing between axial compressor blades and compressor casing housing.
- Bleed valve mounting boss on compressor casing found crushed : pictures 9 and 10.
- Misalignment of the drive gear/splined nut positioning marks which indicates an overtorque : distance between the 2 marks = 1.65 mm – picture 13.
- One blade of the centrifugal compressor found impacted at leading edge : picture 11.
- Rubbing of centrifugal compressor blades onto centrifugal compressor cover : picture 12.
- Presence of a spongy foreign body into compressor casing cover : picture 14.
- Diffuser assembly found eroded and impacted at leading edge of vanes : pictures 15 and 16.
- Modules 1, 2 and 5 found oxidized : picture 17 (module 1).
- Module 3 rear bearing found in good condition despite carbonization in its housing.
- Helicopter's power shaft flector found distorted : picture 18.
- First stage turbine housing rubbed : picture 19.
- Deposit of laterite into the gas generator hollow shaft : picture 20.
- Accessory gearbox cover found cracked : picture 21.
- Presence of grease in the acceleration control chamber : pictures 22 and 23.
- Presence of water into the FCU (picture 24).
- FCU visual inspection (S/N C267B): anticipator angle: 110°, fuel valve angle: approximately 30°; filter removed : small particle collected for analysis.
- The FCU was tested on a specific test rig, and operating characteristics were found correct (see paper works attached), despite a slight P2 leak.
- The FCU was then fitted on an engine and tested on engine test bench in presence of Mr J-F Berthier, Mr P. Mauviot (BEA) and Mr Y. Nicolas (Eurocopter) on March 19th, 2003. All the results were found in accordance with TMF specifications.
- Tachometer box : indicator not triggered.
- Oil pump pack removed : good visual condition.

PARTS SENT TO TURBOMECA'S LABORATORY FOR ANALYSIS:

- Spongy body found into the compressor cover
- MO3 rear bearing
- Small particle found into the FCU fuel filter housing

- Fuel Samples (one collected from the FCU, and one coming from the user)
- Oil sample
- Particle found onto module 5 magnetic plug
- Front support (for analysis of the particles found at the location of the inner wall)

Laboratory analysis results :

7-1 : Fuel and oil samples, particles

- Fuel sample collected into the fuel control unit
  - Clear aspect, presence of some deposits
  - Presence of free water (50% of the sample)

- Oil sample collected into module 5
  - Significant quantity of water (approximately 90%) with a reddish deposit of iron oxide

- Particles
  - Particles taken into the fuel filter and onto module 5 magnetic plug are iron oxide particles.

7-2 : MO3 REAR BEARING

- The MO3 rear bearing exhibits corrosion marks on the bearing race, the inner ring and the rollers. This deterioration is due to the presence of water into the lubrication system (pictures 25-26).
- No other discrepancy was detected on this bearing.

7-3 : Particles found on the front support

Aluminum base, AU2GN-type, not belonging to the engine.
Presence of pigment particles of carbon and titanium paint (flectors ?) as well as cadmium.

7-4 Spongy body found into compressor cover

This body is a non-metallic material.
Turbomeca's lab has no mean to analyze it. It could be analyzed in an external lab if requested by the investigation committee.

Test Result for the Number 1 Engine FCU.

Test Result for the Number 1 Engine FCU.

TURBOMECA - FICHE DE REGLAGE - ESSAIS

	Valeurs relevées
10 NG maxi régulé : *PG = 90 kPa*	
NTL = 0 tr/min - P2 = 750 kPa	
P. inj. = 2 210 kPa	
(Q = 200 $^{+20}_{+0}$ l/h) **NG maxi régulé = 5 000 ± 10 tr/min**	
NTL = 3 650 tr/min - Q = 200 $^{+20}_{+0}$ l/h - **NG = 4 830 ± 10 tr/min .....**	
NG mini régulé : *PG = 90 kPa*	
NTL = 4 350 tr/min - P2 = 750 kPa	
P. inj. = 1 800 kPa	
(Q = 60 $^{+10}_{+0}$ l/h) **NG mini régulé = 3 000 $^{+50}_{-100}$ tr/min**	
Contrôle course de NG	
Course = 3,75 $^{+0,45}_{-0,25}$ mm...	
11 Courbe de statisme NG = f(NTL) : Tableau n° 2.........	
12 Butée NG maxi	
PG = 90 kPa - **NG = 4 914 ± 3 tr/min......**	4916.
13 Butée NG mini	
PG = 90 kPa - **NG = 3 130 ± 10 tr/min....**	
Prise en charge NTL : 103 ± 1 % (4 342 ± 42 tr/min)	103,5
14 Réglage contrôleur de décélération : Tableau n° 3...	
15 Réglage stabilité - Amortissement :	
Tableau n° 4..	
Position chicane isodrome..............	
16 Contrôle statisme NG = f(NTL) : Tableau n° 5	
17 Évolution NG = f(0K) : Tableau n° 6	
***18* Limitation de débit :** *NG = 4 850 tr/min*	
PG = 90 kPa - PI = 1 550 kPa - P2= 750 kPa	
Q = 262,5 $^{+5}_{+0}$ l/h....	262
19 - Contrôle de métallisation page 24	
- Contrôle d'étanchéité et du filtre carburant page 24....	
- Contrôle de freinage page 25	
- Contrôle de stockage page 25...............	

Référence : 0164 24 ??? 0 | N° carton accessoire : | Ed. n° : 6 du 11/04/2001 | Vérifié par : Y. HEGUY 14/09/2001 | ...érateur : Expert ...

CONTROLEE

Référence : 0 764 247 720

N° carton accessoire :

Ed. n° : 6 du 11/04/2001

14/09/2001

Vérifié par : Y. HEGUY

teur : Ba

le :

TURBOMECA - FICHE DE REGLAGE - ESSAIS

TABLEAU 1B - COURBE D'ACCELERATION

NG (tr/min)	Pl (kPa)	P2-P0 (kPa)	Q (l/h) doseur seul		Q (l/h) avec barostat		Q (l/h) avec by-pass
			Désiré	Relevé	Désiré	Relevé	
950	200	0	30^{+6}_{+0}		30^{+6}_{+0}		(1)
1 230	235	20					
1 760	250	40					
2 370	305	80					
2 580	335	100	58^{+3}_{-4}			50	
2 810	380	130					
3 250	510	200	85^{+4}_{-2}				(1)
3 500	635	250					
3 725	825	300					
3 910	930	350			152 ± 2	144,5	
4 050	1 110	400	150^{+5}_{-4}				(1)
4 305	1 475	500			212 ± 3	211	(1)
4 540	1 810	600	223 ± 5				
4 780	2 110	700					
4 850	2 210	750					

(1) Contrôle d'étanchéité du clapet by-pass

TABLEAU 1C - COURBE DE DEMARRAGE

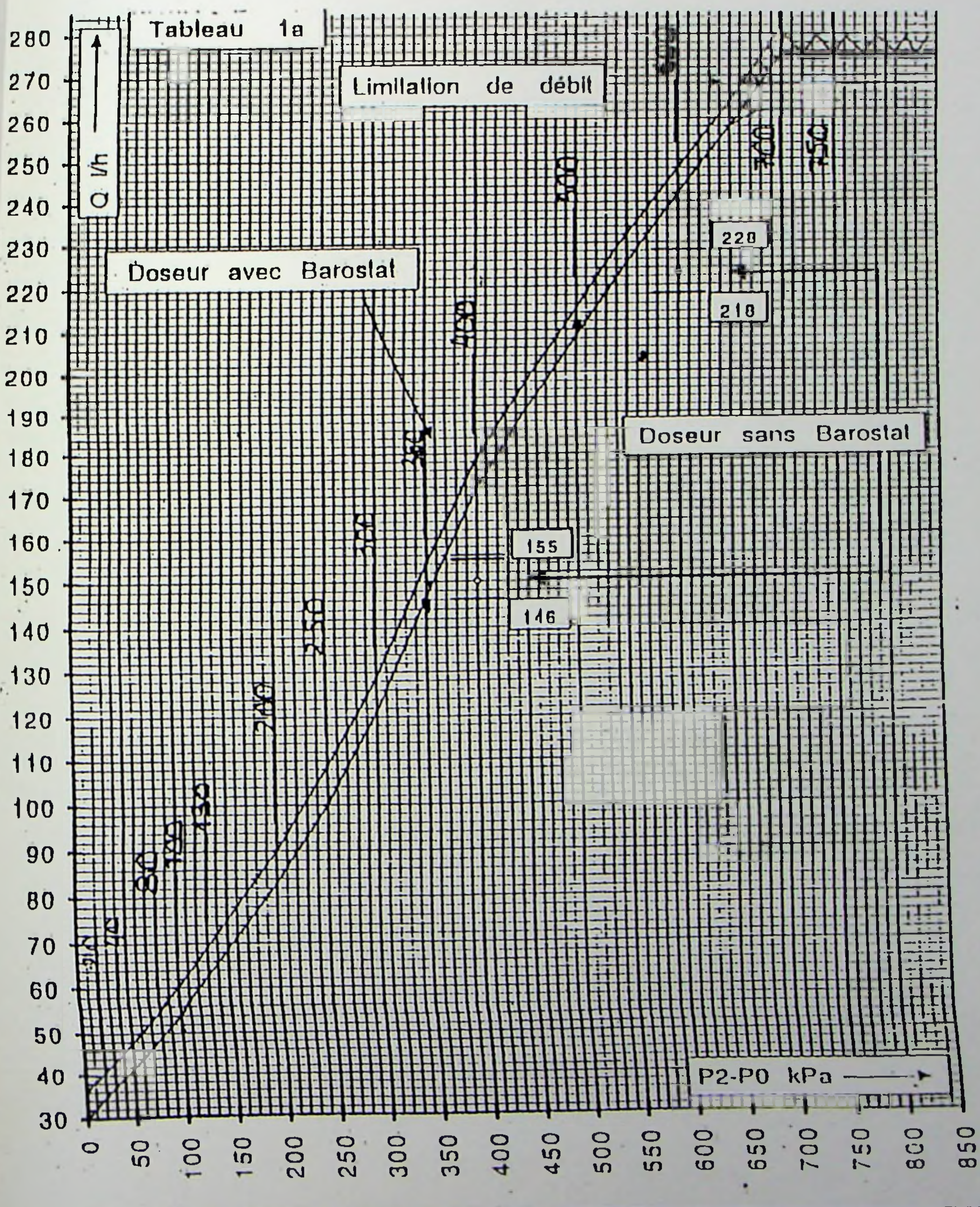
Manette	15°	20°	25°	30°	35°	40°	45°
P2 (kPa)	0	25	35	75	200	350	490
NG (tr/min)	950	1 000	1 500	2 000	3 250	3 910	4 140
Pl (kPa)	200	230	250	320	490	650	940
Q (l/h) désiré	13 ± 2	18 ± 2	29 ± 2	45 ± 2	70 ± 2	100 ± 5	155 ± 10
Q (l/h) réglé							

CONTROLEE

TURBOMECA - FICHE DE REGLAGE - ESSAIS

Régulateur ARRIEL 1C2

	CCT n° : 0 164 24 945 0	N° moteur :	N° série :
	Ed. n° : 6 du 11/04/2001	N° carton accessoire :	Référence :



Vérifié par : Y. HEGUY 14/09/2001

ANNEX 2

THE TECHNICAL REPORT ON
ENGINE No 2.
Serial Number 12148

BY
TURBOMECA SNECMA GROUP
CUSTOMER SUPPORT DEPARTMENT
40220 TARNOS, FRANCE

Turbomeca
groupe snecma

40220 TARNOS
Customer Support Department

TECHNICAL REPORT N° T03 / CR148A

Commercial File N° : WU540

…MENT :	ARRIEL 1C2	S/N :	12148
…OR :	SCHREINER NIGERIA	Date of equipment arrival :	Feb. 10th, 03

…NGINE / MODULE / ACCESSORY	S/N	WORK PERFORMED	TOTAL HOURS	TOTAL CYCLES	HOURS SINCE OH	CYCLES SINCE OH
ENGINE	12148	INSPECTION	2492	3067		
MODULE 1	12155	INSPECTION				
MODULE 2	12151	INSPECTION				
MODULE 3	12150	INSPECTION			167	257
MODULE 4	09554	INSPECTION				
MODULE 5	12153	INSPECTION				

…n official investigation was attended in Turbomeca Tarnos workshop on February 12, 2003, in the presence …f Mr. Faminu (Accident Investigation and Prevention Bureau, Nigeria), Mr. Mauviot (BEA), Mr. Van Der …inden (SCHREINER), Mr. Nicolas (Eurocopter), and Turbomeca's representatives.

…ccident report : 03/001

…° REASON FOR EQUIPMENT RETURN

Post-accident investigation

…° CONCLUSION

Complete dismantling of the engine exhibited several damages (see page 2 for details). All bearings were found seized by corrosion.

Engine and accessories will be modified in accordance with our Quality Assurance Department requirements (see modifications to be embodied)

Signatures :	O.PEYRE	T.DUPUY
		P.O. Date : May 14, 2003

Turbomeca
groupe snecma

TECHNICAL REPORT N° T03 / CR148A

FINDINGS ON ARRIVAL:

- Engine received in a sealed container (pictures 1 to 4).
- Gas generator and free turbine rotating assemblies found seized.
- Exhaust pipe found distorted.
- Impacts at the location the HE box (one cover missing).
- Axial compressor blades impacted over 2 mm and eroded over 0.5 mm.
- Harness sheaths found in good condition.
- Bleed valve in open position.
- Compressor casing found distorted at the location of the bleed valve boss.

FINDINGS ON TEST RIG BEFORE DISASSEMBLY:

No tests performed before the disassembly.

FINDINGS AFTER DISASSEMBLY:

- Very small metal particle found onto module 5 magnetic plug.
- Starter drive shaft found ruptured.
- Misalignment of the drive gear/splined nut positioning marks which indicates an overtorque : distance between the 2 marks = 1.40 mm.
- Rubbing of centrifugal compressor blades onto centrifugal compressor cover, one blade of the centrifugal compressor found bent : pictures 5 and 6.
- Presence of a spongy foreign body into the compressor casing cover : picture 7.
- Rubbing of first stage turbine blades rear platform onto second stage nozzle guide vane hub leading to an accumulation of metal : picture 8.
- MO3 rear bearing found in good condition.
- Rubbing of free turbine blades onto its housing : picture 9.
- Helicopter's power shaft flector found deformed : picture 10.
- Module 4 : slight free turbine blades metallization.
- Module 5 found oxidized.
- FCU inspection (S/N 164M): Anticipator quadrant deformed, anticipator lever out of range and deformed (picture 11).
- The FCU was then tested on a specific test rig, and all operating characteristics were found correct (refer to paper works attached).
- Presence of water in the acceleration control chamber : picture 12.
- Oil pump pack removed : good visual condition.
- Tachometer box : indicator not triggered.

PARTS SENT TO TURBOMECA'S LABORATORY FOR ANALYSIS:

- Spongy body found into the compressor cover.
- Fuel samples (one collected from the FCU, and one coming from the user).
- Oil samples (X2).
- Accumulation of metal found on second stage nozzle guide vane.

Turbomeca
groupe snecma

TECHNICAL REPORT N° T03 / CR148A

Laboratory analysis results :

7-1 : Fuel and oil samples, particles

- Fuel sample collected into the fuel control unit
  - Clear aspect, presence of some deposits
  - No free water

- Oil samples collected into modules 1 and 5
  - Significant quantity of water (approximately 90%) with a reddish deposit of iron oxide

- Accumulation of metal found on second stage nozzle guide vane
  - Material = NW 12 KCAT Hf (DS200, material of first stage turbine blades)

7-4 Spongy body found into compressor cover

This body is a non-metallic material.
Turbomeca's lab has no mean to analyze it. It could be analyzed in an external lab if requested by the investigation committee.

Test Result for the Number 2 Engine FCU.

TURBOMECA - FICHE DE REGLAGE - ESSAIS

Turbomeca groupe snecma

10 SEP. 2002

DIFFUSION CONTROLEE

Valeurs relevées

1 **Pression Pompe débit nu**

NG = 4 000 tr/min - P.pe = 3 350 $^{+100}_{+0}$ kPa....

2 **Robinet de débit**

Butée manette fermée.....

NG = 2 850 tr/min Début ouverture..............

3 **Débit carburant doseur ouvert** : $\alpha = 52°$

NG = 4 820 tr/min - P2 = 750 kPa - ΔP kPa ....

P. inj. = 2 210 kPa - Q = 275 $^{+5}_{+0}$ l/h ..

Débit mini doseur fermé :

NG = 3 130 tr/min - P2 = 750 kPa

P. inj. = 500 kPa - Q = 29 ± 1 l/h ...

Contrôle fuite diaphragme doseur < 5 l/h .

4 **Robinet secours doseur fermé**

NG = 3 130 tr/min - P2 = 750 kPa - P. inj. = 500 kPa

Ouverture robinet 62 ± 2°...

Débit maxi robinet $\alpha = 90°$

NG = 4 517 tr/min - P2 = 750 kPa - P. inj. = 1 580 kPa

Q 190 $^{+16}_{+0}$ l/h..... 204.

$\alpha = 52°$

5 **Courbe d'accélération** : Tableaux n° 1a-1b ....

6 **Courbe de démarrage** : Tableau n° 1c .... conforme

7 **Contrôle du filtre régulateur**......................................

8 **Contrôle de la pression détendue**

NG = 4 500 tr/min - P2 = 750 kPa - P. inj. = 1 580 kPa

Pression détendue = 400 $^{+50}_{+0}$ kPa.....

9 **Contrôle pression modulée NG et NTL**

NG = 4 500 tr/min - P2 = 750 kPa - P. inj. = 1 580 kPa

Pression Mod. NG = 400 $^{+50}_{+0}$ kPa......

Pression Mod. NTL = 290 $^{+30}_{-20}$ kPa .....

Référence : 0 164 24 873 0

N° carton accessoire :

Ed. n° : 6 du 11/04/2001

Vérifié par : Y. HEGUY 14/09/2001

Opérateur : Expert

ON CONTROLEE

N° série : 164 M — Référence : 0 164 24 8780
N° moteur : 12148 — N° carton accessoire :
CCT n° : 0 164 24 945 0 — Ed. n° : 6 du 11/04/2001
Établi par : J.J. HUSTAIX 14/09/2001 — Vérifié par : Y. HEGUY 14/09/2001
…ôle :
…ateur :

TURBOMECA - FICHE DE REGLAGE - ESSAIS

TABLEAU 1B - COURBE D'ACCELERATION

NG (tr/min)	PI (kPa)	P2-P0 (kPa)	Q (l/h) doseur seul		Q (l/h) avec barostat		Q (l/h) avec by-pass
			Désiré	Relevé	Désiré	Relevé	
950	200	0	30 $^{+6}_{+0}$		30 $^{+6}_{+0}$		(1)
1 230	235	20	[redacted]	[redacted]			[redacted]
1 760	250	40	[redacted]	[redacted]			[redacted]
2 370	305	80	[redacted]	[redacted]			[redacted]
2 580	335	100	58 $^{+3}_{-4}$	56		56	[redacted]
2 810	380	130	[redacted]	[redacted]			[redacted]
3 250	510	200	85 $^{+4}_{-2}$				(1)
3 500	635	250	[redacted]	[redacted]			[redacted]
3 725	825	300	[redacted]	[redacted]			[redacted]
3 910	930	350	[redacted]	[redacted]	152 ± 2		[redacted]
4 050	1 110	400	160 $^{+5}_{-4}$			175	(1)
4 305	1 475	500	[redacted]	[redacted]	212 ± 3	210	(1)
4 540	1 810	600	223 ± 5				[redacted]
4 780	2 110	700	[redacted]	[redacted]			[redacted]
4 850	2 210	750	[redacted]	[redacted]			[redacted]

(1) Contrôle d'étanchéité du clapet by-pass

TABLEAU 1C - COURBE DE DEMARRAGE

Manette	15°	20°	25°	30°	35°	40°	45°
P2 (kPa)	0	25	35	75	200	350	490
NG (tr/min)	950	1 000	1 500	2 000	3 250	3 910	4 140
PI (kPa)	200	230	250	320	490	650	940
Q (l/h) désiré	13 ± 2	18 ± 2	29 ± 2	45 ± 2	70 ± 2	100 ± 5	155 ± 10
Q (l/h) réglé							

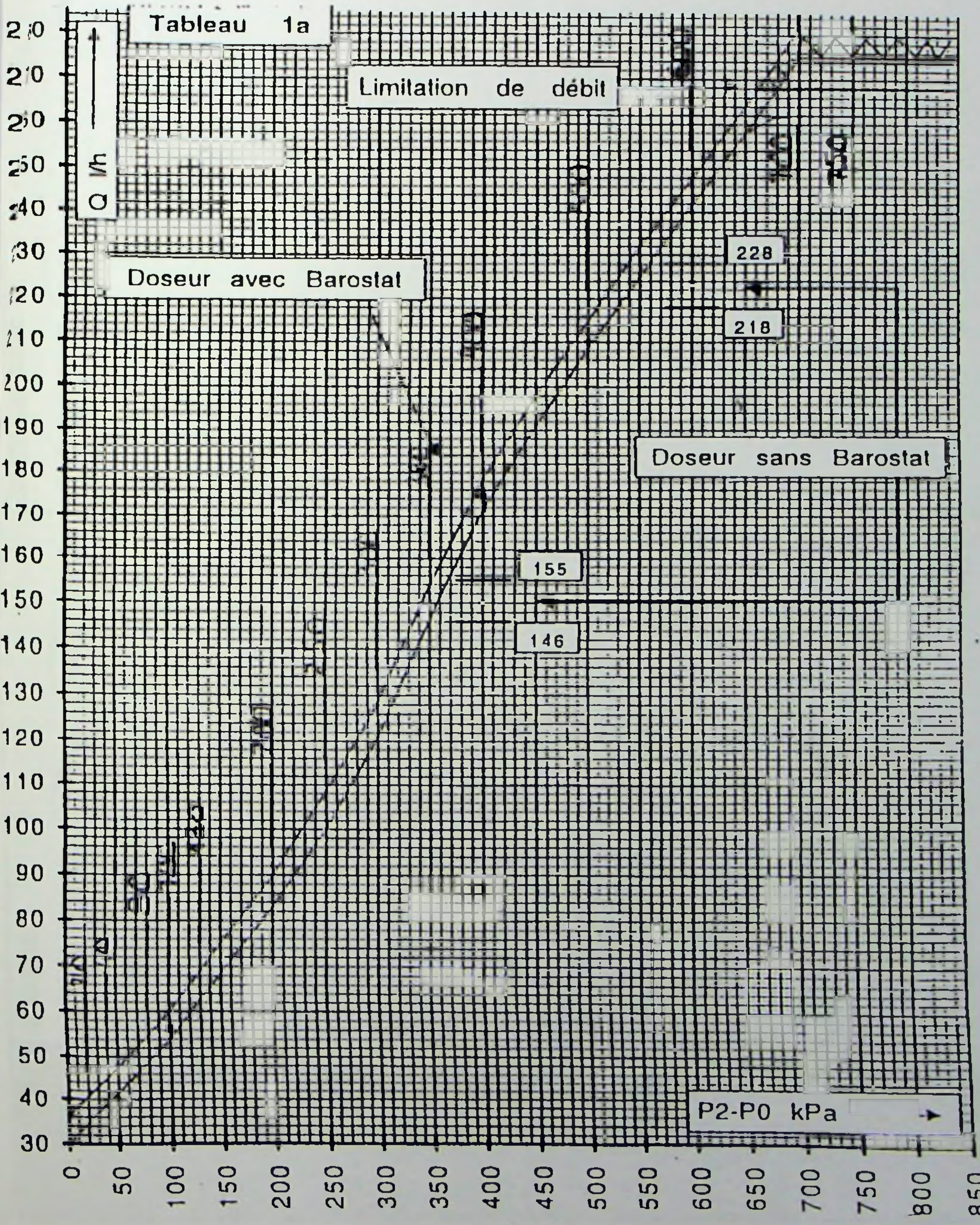
NTROLEE

TURBOMECA - FICHE DE REGLAGE - ESSAIS

Régulateur ARRIEL 1C2

	CCT n° : 0 164 24 945 0	N° moteur : 12148	N° série : 164 M
	Ed. n° : 6 du 11/04/2001	N° carton accessoire :	Référence : 0 164 248780

4/9



N CONTROLEE

TURBOMECA - FICHE DE REGLAGE - ESSAIS

Régulateur ARRIEL 1C2

: 11/02/2003.	CCT n° : 0 164 24 945 0	N° moteur : 12 148	N° série : 164 M
r :	Ed. n° : 6 du 11/04/2001	N° carton accessoire :	Référence : 0 164 248 760

7/9

TEMPS DE REPONSE

X - Base de temps (0,8s) ou (1s) = 10 DIV

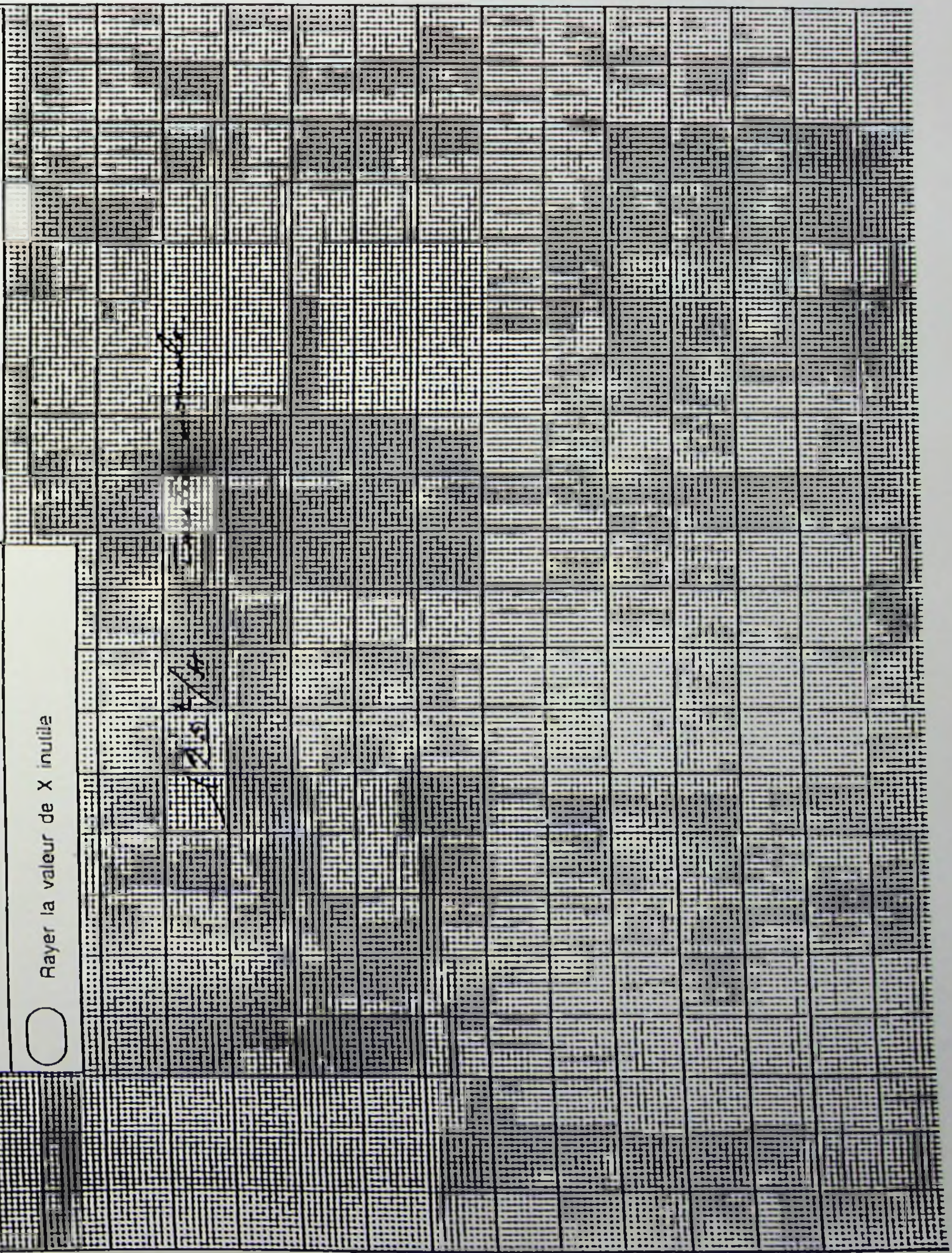
Y - 50 mV = 10 DIV

STABILITE

X - Base de temps (4s) ou (5s) = 10 DIV

Y - 200 mV = 10 DIV . = 4,2 l/h

Rayer la valeur de X inutile



par : JJ. HUSTAIX 14/09/2001 | Vérifié par : Y. HEGUY 14.09.2001

ANNEX 3

THE TECHNICAL REPORT

ON THE EMERGENCY FLOATATION GEAR

BY

AERAZUR
58 RUE DE SEGONZAC,
16103 COGNAC, FRANCE
RENSEGNEMENTS GENERAUX

AERAZUR

COMPTE RENDU D'EXAMEN TECHNIQUE

I - RENSEIGNEMENTS GENERAUX

- Lieu de l'examen : AERAZUR 58 rue de Segonzac – 16103 COGNAC
- Date : 22/05/03
- Participants :
  - EC : Sidney PAN, Jean Louis HORCHOLLE
  - ARZ : Jean-Christian LECORDIER, Christian RIVEREAU, Jean-Jacques BENOIT

Client:

EUROCOPTER

Matériel concerné

- Désignation : FLOTTABILITE AVANT DROITE AS366
- Référence : 202402-3

  Cet ensemble est constitué de : 1 ballon 204038-3 N° 726 – date de fab. : 04/1999
  1 conteneur carbone N°205 – date de fab. : 04/1986

II - MOTIF DU RETOUR

Après percussion sur appareil, il a été constaté que la toile de fermeture inférieure était toujours liée par le laçage (drisse à casser) à la toile de fermeture supérieure.

III - CONSTAT SUR LE MATERIEL / ANALYSE

Toiles de fermeture

- La toile supérieure et la toile inférieure sont lacées (drisse à casser R721 A805 – résistance 25 daN).
- Le laçage n'est pas conforme, il y a un nœud à chaque œillet. *(photo 1)*
- Des découpes ont été pratiquées sur la mousse de protection autour des œillets. *(photo 2)*
- Le polycarbonate est cassé en bordure des toiles suite au vieillissement excessif. *(photo 2 et 3)*

Usine de Cognac : BP 81 - 16103 Cognac - France
Tél : + 33 5 45 83 20 20 Fax : + 33 5 45 83 20 70

Siège social : 2, rue Maurice Mallet - 92130 Issy les Moulineaux
Tél : + 33 1 41 23 23 23 Fax : + 33 1 46 48 74 79

S.A.S.U. au capital de 106 500 000 € - AERAZUR - B 692 023 864 - RCS Nanterre

ODIAC AERAZUR

TECHNICAL EXAMINATION REPORT

- GENERAL INFORMATION

- Place of examination: AERAZUR 58 Rue de Segonzac – 16103 COGNAC
- Date: May 22, 2003
- Participants:
  - EC: Sidney PAN, Jean Louis HORCHOLLE
  - ARZ: Jean-Christian LECORDIER, Christian RIVEREAU, Jean-Jacques BENOIT

Customer:
EUROCOPTER

uipment concerned

Description: SA366 EMERGENCY FLOATATION GEAR RH FORWARD PONTOON

Part Number: 202402-3
This assembly is composed of: 1 pontoon 204038-3 No. 726 – Manufacturing date: 04/1999
1 carbon container No. 205 – Manufacturing date: 04/1986

– REASON FOR RETURN

After the inflation cylinders were actuated on the aircraft, it was found that the lower fabric cover was still attached to the upper fabric cover by the lacing (snap-cord).

I – FINDINGS ON THE EQUIPMENT / ANALYSIS

Fabric covers

- The upper and lower covers are laced (snap-cord R721A5805 – strength = 25 daN).
- The lacing is not compliant; there is a knot at each eyelet *(photo 1)*.
- Cutouts have been produced on the protective foam around eyelets *(photo 2)*.
- The polycarbonate is broken at the edges of the covers subsequent to excessive aging *(photos 2 and 3)*.

ZODIAC

AERAZUR

Conteneur

- Présence de trous supplémentaires.
- La carbone est cassé en plusieurs endroits. *(photo 4 et 5)*
- Oxydation importante de plusieurs pièces métalliques. *(photo 5)*
- L'AMS745B88 (mise en place d'un bossage) n'a pas été appliquée sur ce conteneur.

Montage des toiles de fermeture sur le conteneur

- Les boutons pression de la toile supérieure ont été remplacés par des rivets plastique.
- Les rivets tubulaires ont été sertis avec un outillage inapproprié (tête de rivet écrasé).
- Le SB365-69-001 n'a été que partiellement appliqué : absence des renforts métalliques aux extrémités supérieures du conteneur.

Entretien du ballon

- RAS suivant documents de suivi présentés par EC.

IV - CONCLUSION

Le mauvais état des toiles de fermeture, du conteneur et le laçage non conforme (un nœud à chaque œillet augmente la résistance du système à casser) sont à l'origine de l'ouverture du conteneur par la rupture de la toile de fermeture inférieure au niveau de sa fixation.
Ces défauts proviennent d'un vieillissement de ces éléments, éléments non changés lors des révisions.

Ce matériel doit être réformé. Nous conseillons à EC d'informer son client d'en faire de même pour les 3 autres matériels (flottabilités AVG, ARG et ARD) équipant l'appareil.

JJ BENOIT
Service Qualité

JM DALDOSS
Responsable du Service Qualité

Destinataire :

- ARZ : UC/QL – DSE/DPG –ARS/CHR
- EC : JL HORCHOLLE - S. PAN

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ntainer

Discovery of additional holes.
The carbon is broken at several places *(photos 4 and 5)*.
Significant oxidation of several metal parts *(photo 5)*.
MOD745B88 (introduction of a boss) has not been embodied on this container.

tallation of the fabric covers on the container

The press-studs of the upper cover have been replaced with plastic rivets.
The hollow rivets have been swaged using an inappropriate tool (rivet head flattened).
Compliance with SB365-69-001 has been ensured partially: there are no metal reinforcements at upper ends of the container.

aintenance of the pontoon

thing to report according to the follow-up documentation presented by EC.

ONCLUSION

e poor condition of the fabric covers, the container and the non-compliant lacing (one knot at ch eyelet increases the strength of the snap-release system) have caused the container to open e to the failure of the lower fabric cover at its attachment.
ese defects are due to aging of the parts which were not replaced at the overhauls.

is equipment must be withdrawn from service. We advise EC to inform its customer to do the me thing for the 3 other equipment items (LH forward, LH aft and RH aft flotation gear ntoons fitted to the aircraft).

JJ BENOIT
Quality Department

JM DALDOSS
Quality Department Manager

ddressee:
ARZ: UC7QL – DES/DPG – ARS/CHR
EC: JL HORCHOLLE – S. PAN

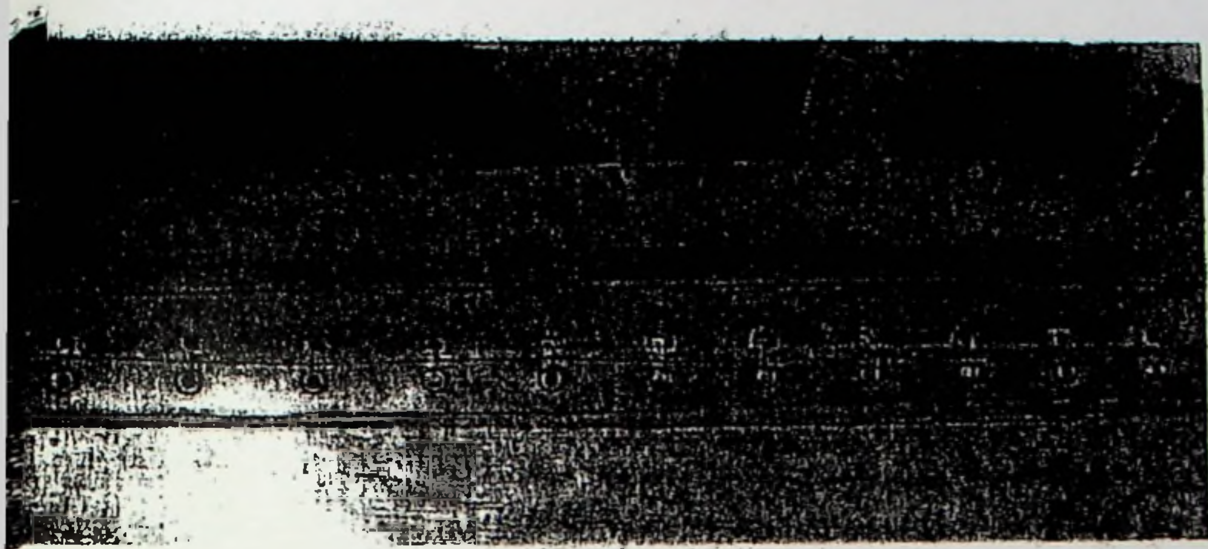


photo 1

photo 2

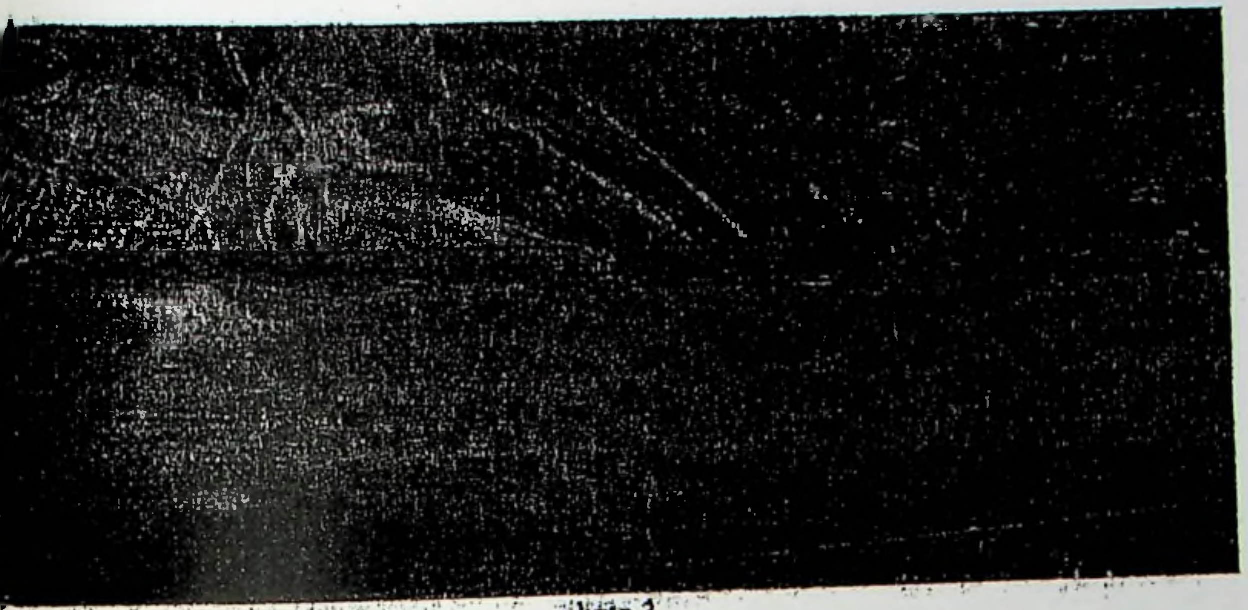


photo 3

photo 4

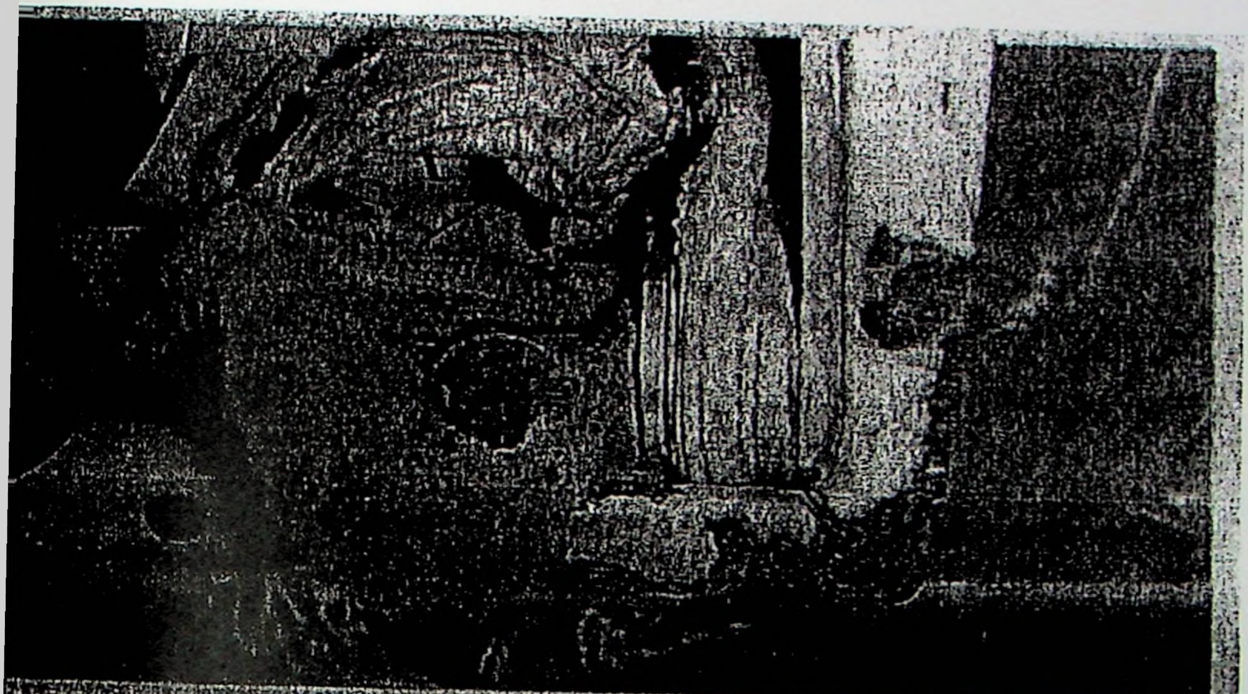


photo 5

ANNEX 4

The result of the examination of the G-switch
produced by CROUZET Automatismes the manufacturer.

ORIGINAL
(TAMPON ROUGE)

Page A

REFERENCE : C.CT.3810.CX.0001
REVISION : 0
DATE : 04/04/03
CHRONO : 3810CX01.doc

OBJET/SCOPE : **SWITCH SP 3810 EUROCOPTER:**

TITRE/TITLE : **COMPTE-RENDU D'EXPERTISE du 04/04/03**

	Nom / Name	Fonction / Function	Date	Visa
tabli par ....: / Vritten by ....:	MJ. BEGUIN	Qualité	11/4/03	[signature]
pprouvé par ....: / pproved by ....:	R. DUCKI	Responsable Qualité	15/4/03	[signature]
utorisé par ....: / uthorized by ......:	M. ROZIERES	Commercial	16/4/03	[signature]

IFFUSION

ROUZET AUTOMATISMES

QPF : MJ. BEGUIN..................... (1ère page)
SC....: M. ROZIERES .... (1ère page)
SAV.: JM. VAREILLE................. (1ère Page)
GD...: **Original**

EXTERNE

EUROCOPTER (1 ex)

Crouzet

Feuille de révision / Documentation change record

Les modifications de la dernière révision sont en **caractères gras & italiques**
The change of the last issue are in ***italic & bold-face characters***

Rév./ par Rev./ by	Pages rév Rev. pages.	Description de la modification Descriptions of modifications	Date
0/ BEGUIN	/	- Création.	04/04/03

Ce document comporte 4 page (s) de texte + 2 Annexe(s)
This document contains 4 page (s) of text + 2 Attachement (s)

La révision de ce document annule la révision précédente
Revision of this document supersedes previous revision

CONTENTS

ATTACHMENTS

Courtesy translation

1 - SUBJECT

This document gives the results of the examination carried out by CROUZET Automatismes on the switch SP 3810 in the presence of EUROCOPTER and the BEA. Following an accident involving a Dauphin N2 helicopter, the BEA and EUROCOPTER wanted the switch to be examined.
This switch is used to cut-off the CVR (cockpit voice recorder) when the aircraft exceeds a certain acceleration. The switch is in the actuated position during the flight. On impact, the switch disengages and opens the electrical system. The information recorded on the CVR is thus saved in the event of a significant impact, or even accident. On the damaged aircraft, the CVR was cut-off 8 minutes before the impact. Helicopter characteristics: DAUPHIN N2, S/N 6448, call sign: 5N-BBS, customer: SCHREINER, accident 3 January 2003.

Persons present at examination:

- BEA (Investigation and analysis department for civil aviation safety): Mr. MAUVIOT, Technical Investigator
- EUROCOPTER: Mr. NICOLAS, Accident Investigation Manager; Mr. MONDOU, Avionics and Systems Manager
- CROUZET: Mrs. BEGUIN, Quality

2 - IDENTIFICATION OF PRODUCT

CROUZET reference: SP3810 Code 83 990 049
Date of manufacture: 04-92.

3 - REASON FOR EXAMINATION

Examination of switch following an accident. The switch was recovered in the water.

4 - EXAMINATION PROCEDURE AND RESULTS

4.1 - Inspection before examination

General appearance of product: a screw on the connector side was missing. The 4 screws on the mechanical sub-assembly side were rusted.

4.2 - Operational check

The switch was tested on the production rotating star which allowed the acceleration value at which the switch disengages to be known.

Courtesy translation

ne witch was manually engaged. It was placed in a radial position on the rotating star. The
ecical contact was not made, the system remained open. The microswitch was not actuated.
ucessive acceleration tests took place. After each test, we noted whether the switch was
isengaged despite there being no electrical signal.
es at 258 rpm (6.5g) and 274 rpm (8g): the switch did not disengage.
t 28 rpm (9.7g), it disengaged.
cording to these initial tests, the microswitch changed status and operated correctly.
le measurement: the switch disengaged at 291 rpm (9.2g) with the microswitch status changing.
celeration test in the other switch positions:
tgent position: disengagement at 302 rpm for 287 rpm max.
vrtical position: disengagement at 285 rpm for 271 rpm max.
le measurement in radial position: disengagement at 300 rpm.

.:- Examination

.he product was opened by unscrewing the 4 screws. The microswitch 83 133 125 was extracted.
1 screws were significantly oxidized. The parts inside the switch were also oxidized. The pin used
set the switch was covered with contamination. (Refer to photos in attachment 1).

The pin was extracted. Switch was reinstalled keeping the mechanical sub-assembly and using a
w microswitch and pin.

celeration tests:

adial position: disengagement at 262 rpm

angent position: disengagement at 272 rpm

ertical position: disengagement at 263 rpm.

e product complied with requirements. The mechanical sub-assembly of the examined product
erefore complied with requirements.

The microswitch was opened: significant corrosion of components. Refer to photos in attachment 2.
ne microswitch operated correctly.

<u>- ORIGIN AND IMPUTATION OF FAULTS</u>

he significant corrosion of the parts explains the operation of the switch after a few maneuvers and
e disengagement above the maximum values. The mechanical sub-assembly and the microswitch
perate correctly.
he product is not implicated in the accident and in the application in general.

Courtesy translation

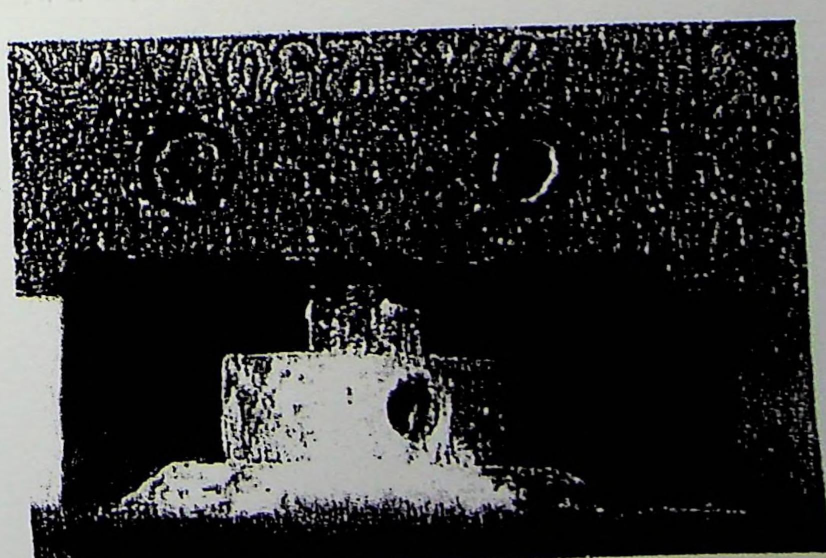
6 – CORRECTIVE ACTIONS

6.1. For examined product: None

6.2. For products to be delivered: None

CROUZET

CROUZET



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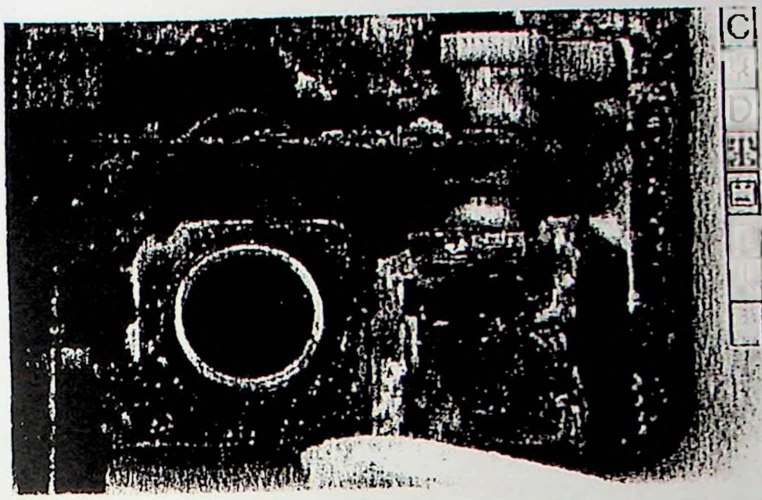

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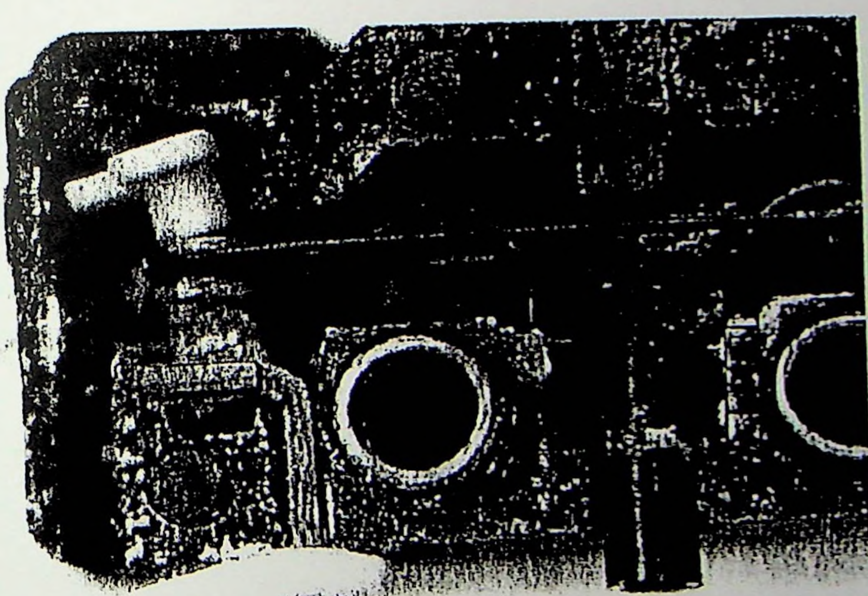


CROUZET

ANNEX 5

The result of the metallurgical test performed on
the scissors link bolt 365a31-1175-21

and

its spacer Part Number 704a33-698-023.

SCISSOR LINK PIN 365a31-1175-21 AND SPACER 704a33-698-023

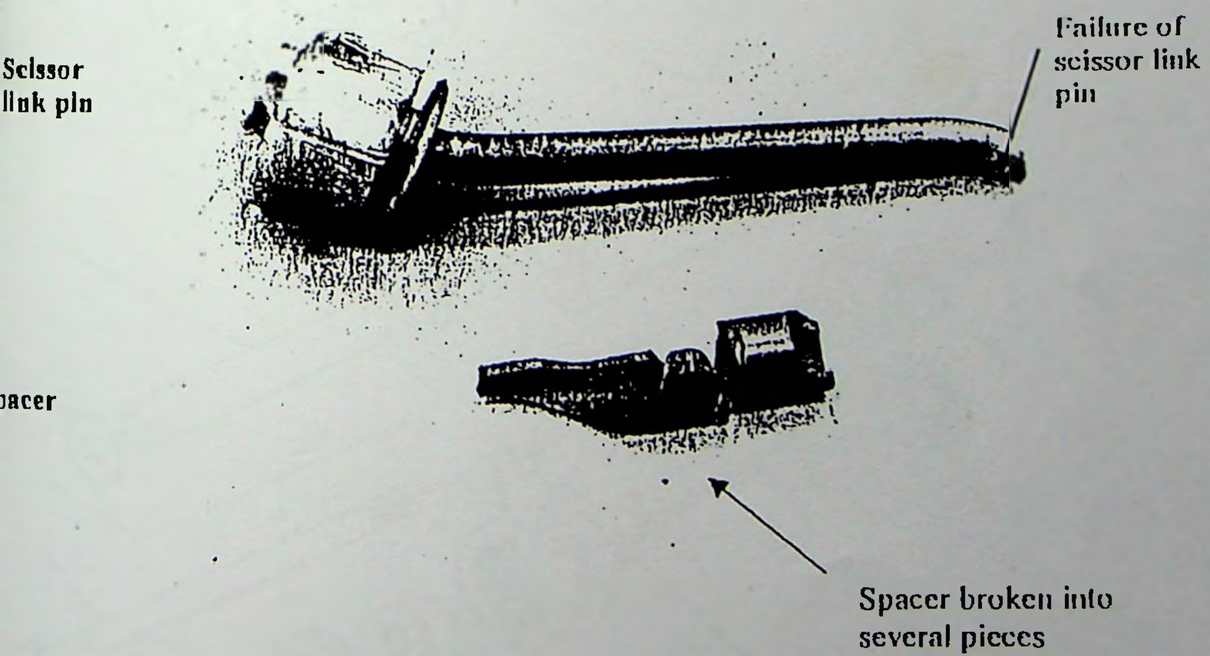
- FINDINGS:

cissor link pin:
ailure and distortion.
EM examination reveals **static failure.**

pacer:
he spacer is failed at several points.
he two pieces sent to the laboratory had **static failures**.
he nature of the failure was confirmed by comparison between the topographies of he failures under inspection and the topographies of a static failure induced in the aboratory.

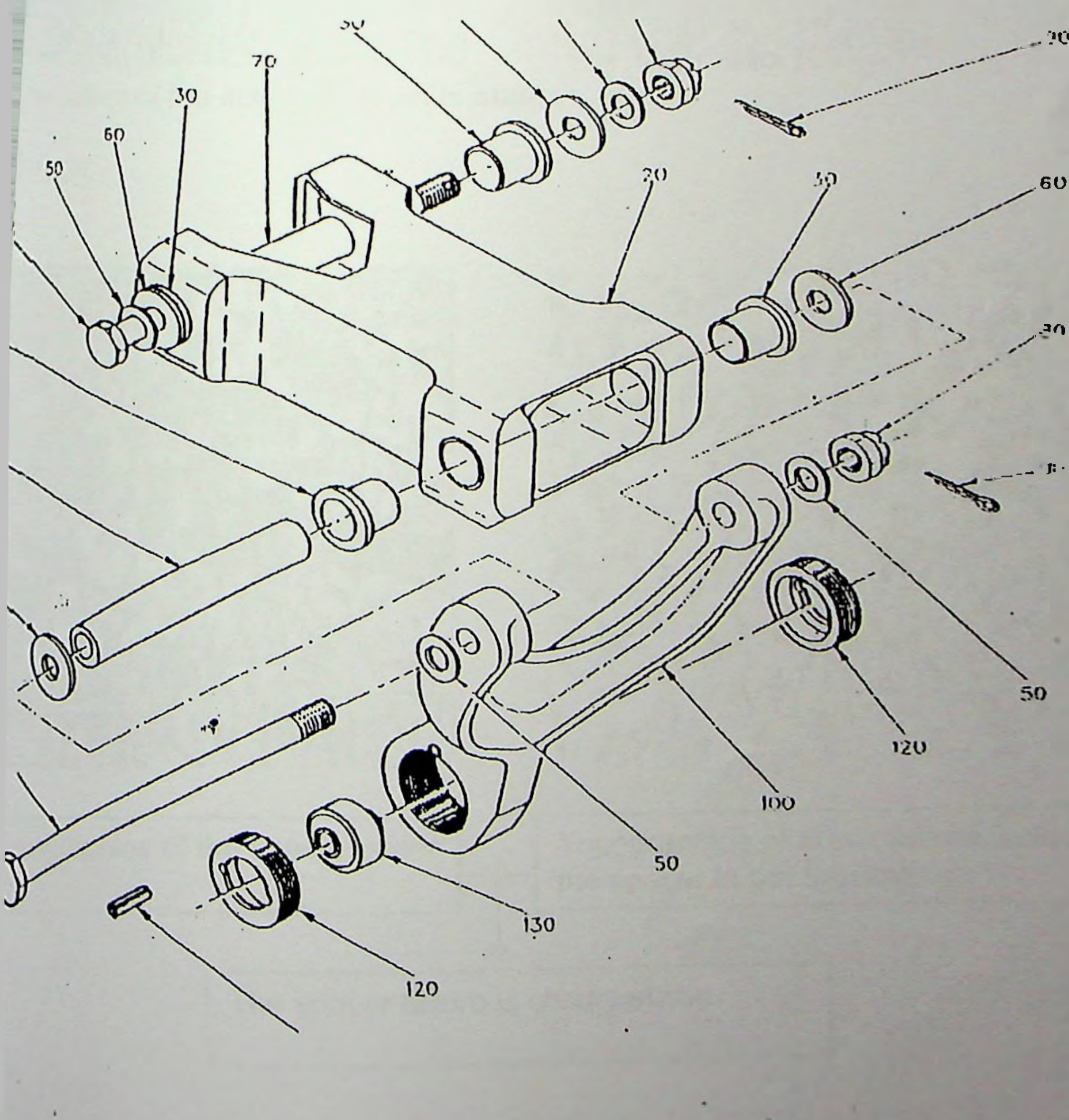
2 – PARTIAL SUMMARY:

The damage found is consecutive to the accident.



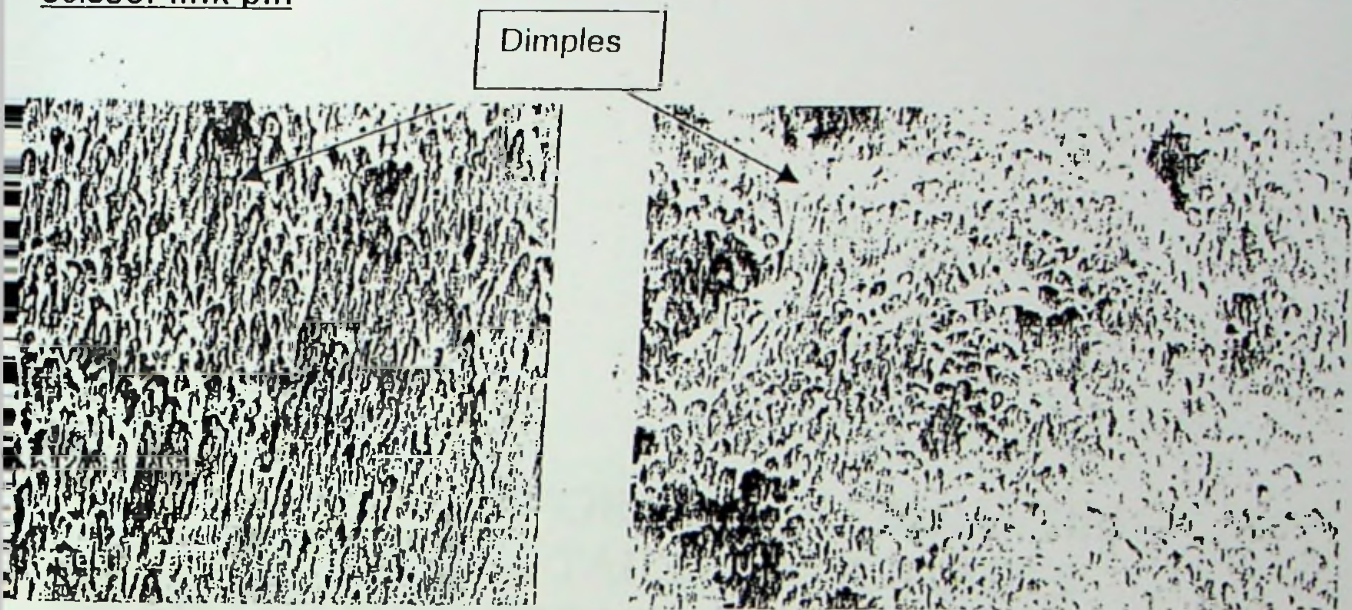
SCISSOR LINK PIN 365a31-1175-21 AND SPACER 704a33-698-023

ASSEMBLY DIAGRAM



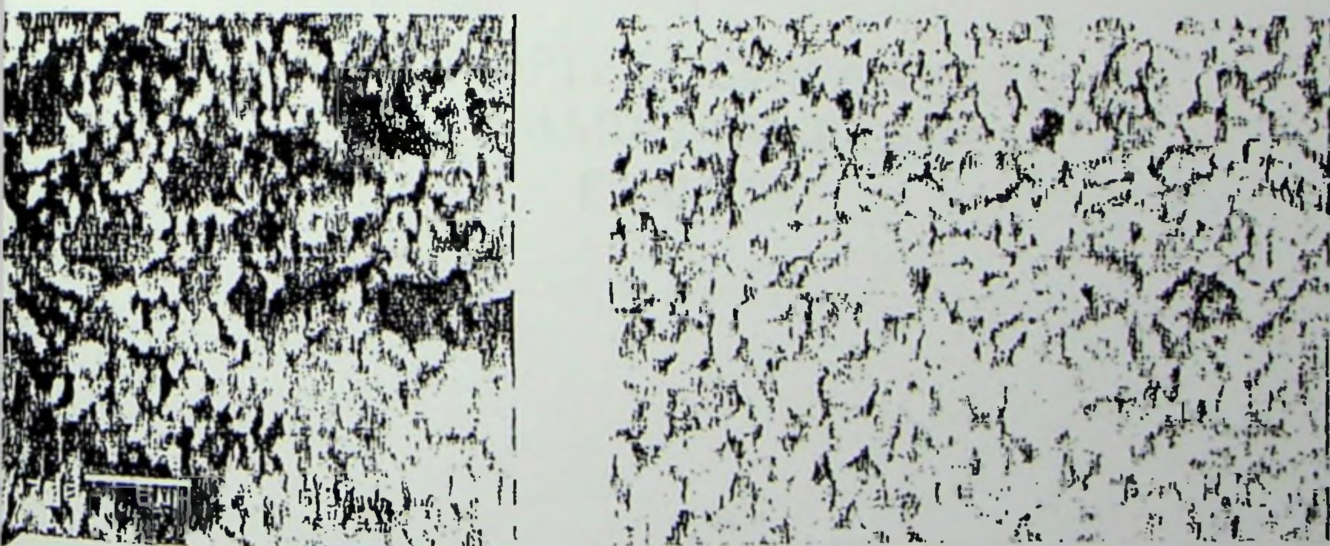
SEM topograpgy images

Scissor link pin



The failure of the scissor link pin is static.

Spacer



…opographies of the spacer under …on.

Topographies of static failure induced on the spacer in the laboratory.

The spacer failure is clearly static.

ANNEX 6

THE SERVICE INFORMATION BULLETIN ON THE TAIL ROTOR BLADES EMANATING FROM THE 5N-BBS ACCIDENT

ISSUED BY

EUROCOPTER COMPANY LTD.
13725 MARIGNANE CEDEX
FRANCE

INDUSTRIAL COMPETENCE CENTER QUALITY DEPARTMENT	MATERIALS LABORATORY REPORT O/IQL No. 3017/2003	Page 1/50 Date: 20/10/03 Author: N. MOURRE

TITLE

ACCIDENT TO 365 N2 NIGERIA (SCHREINER)

A/C No.	: DAUPHIN N2	PART No.	: 365A 12 0020 02
CUSTOMER	: SCHREINER	ORIGIN	: STSV OTMP/M
OPERATING HOURS	: 800 h	REF. DOC.	: OIQP – PG/CL n°2003.01.22.01
SUPPLIER	: MARIGNANE	No. ENCLOSED NOTE:	

KEYWORDS: FLEET FOLLOW-UP / ACCIDENT / UTILIZATION / FAILURE / KEVLAR

In case of litigation, the reference version is the french one.

1. CONTEXT

After an initial bang, the helicopter lost its yaw and roll stability, and then became stable again. The crew detected a burning smell and decided to return to their base.

During the final approach, a second bang occured, the helicopter started rotating to the left and hit a container on a barge moored at a wharf.

In the first impact, the pilot's door hit the front of the container. The second impact on the horizontal stabilizer completely severed the Fenestron.

The helicopter was found lying upside down in the water beside the barge.

The tail rotor suffered the following damage:

The TGB tube and flared coupling were both broken, the duct was holed in two places, and the five blades had lost their spanwise airfoil sections.

The most damaged blade – No. 35317 - was sent for laboratory investigation.

A program of investigation was defined after the parts were received in Marignane.

The following composite parts were examined:

- The most damaged blade No. 35317.
- The TGB carbon support tube
- The rotor hub and the other blades (overall examination)
- The MGB fan

INDUSTRIAL COMPETENCE CENTERS		OTHER CENTERS		QUALITY
OIQ→OIQL	CIt	OTI	OTM	QA
OI		OTIS	OTMP	QAME
OID→OIDO		OTIN	OTMP/M	OIQP
OIP→OIPT		STSV	OTMC/M	

Group Head	Department Head "Materials Laboratory"	Quality Manager for the Industrial Competence Centers
Signed	Signed	Signed
O. GOUPILLON	M. PIERANTONI	JM. POULIER

I- CONCLUSIONS

1- Overall Damage to Rotor

- On the most damaged blade (No. 35317), all that is left on the TRH is the attachment insert with part of the Kevlar tie bar assembly (trailing edge strand).
- The next blade No. 36853 (blade No. 11) was cut in half, and its tip section was missing.
- The Fenestron duct was cut, with two holes at the 11 o'clock and 12 o'clock positions.
- The TGB flared coupling was broken.
- The TGB support tube was broken.

2- Blade No. 35317

The blade has fractured in two places:
- the tie bar assembly had failed at the bushing on the leading edge side.
- the tie bar built-in restraint in the blade had failed at the seal termination (station X158).

The fracture near the bushing was a **static failure**.
The fracture at the built-in restraint was a **fatigue failure**.
The tie bar fracture was partial through the thickness: 1.3 mm out of a total thickness of 3.5 mm was lost over 5 mm of the total 13.2 mm chord length.

The checks performed – the manufacturing file was examined and the tracer threads counted – indicated that blade No. 35317 was compliant with its definition.

3- Blade No. 36853

Blade No. 36853 was blade No. 11, the blade following after.
The blade had fractured at mid span, and the leading edge was deformed and scratched.
Chromium oxides were found in the microanalysis of the leading edge; they could correspond to the protective coating on the bearing of damaged blade No. 35317 (the bearing was not found).

4- Examination of the Other Blades on the Tail Rotor

Two other rotor blades were destructively examined in the root area at X158 where the following damage was found:
- a white mark on the lower surface of the trailing and leading edge strands of the tie bar assembly.
- a white mark was analyzed using the MEB method, which indicated damage to the resin with a few broken Kevlar fibers present.

5- TGB Tube

No non-conformities were found in the analysis of the manufacturing file, the part complied with its definition.
The tube fractured in two places:
- one fracture at the built-in restraint with the duct (break at bearing A)
- a second fracture at one of the attachments picking up the TGB (break at bearing B)

Both fractures were caused by static loading. The tube was bent by the fracture of the damaged blade n°35317. When it fractured, this blade generated an imbalance on the rotor that caused the hub to move, which in turn fractured the tube and flared coupling.

6 MGB Fan and Guide Vane Assembly

Al the fan blades were broken.
A visual examination of the guide vane assembly revealed that one of the fan blades had hit the guide vane assembly.
All the blades had the same fracture topography, i.e. **fast static failure**.

7- Summary

Based on the observations made, the rotor was probably damaged according to the following sequence:

- failure of blade No. 35317 after incipient fatigue at X = 158 mm, followed by the static failure of the other parts of the blade.

- static failure of blade No. 36853, followed by the failure of blade No. 33317 (blade No. 36853 followed after blade No. 33317)

- other rotors components damaged and broken by the two preceding events. This scenario is confirmed by the numerous visible rub marks and impacts.

The examination of the other blades at **X** = 158 confirmed the presence of incipient damage in the form of white marks and causing local deterioration of the resin combined with damage to the fibers.
Although the reason for the incipient fatigue was not positively identified as several parameters (loading, temperature, aging, etc.) could have been involved.

eurocopter
an EADS Company

T.F.S. No. 00000131 dated June 5,2003
EUROCOPTER - MARIGNANE - TLX 42506F

IMPORTANT INFORMATION

AIRCRAFT	:	AS 365	Civil Versions:	N1, N2, N3
			Military Versions:	F, FI, K
AIRCRAFT	:	SA 366	Civil Version:	G1
AIRCRAFT	:	AS 565	Military Versions:	AA, MA, MB, SA, SB

ATA: 64

SUBJECT: TAIL ROTOR
TRH Blades installed on the 11-Blade Tail Rotor Hub

Dear Customer,

EUROCOPTER informs you of the issue by express mail of Information Letter No. 008-2003 attached herewith.

Exceptionally, this edition is also forwarded by the T.F.S. (telex/fax service) system in order to inform you as rapidly as possible.

No. DA 008-2003

ice à la Clientèle
ction Technique

rignane Cedex - France
(0)4.42.85.97.07 - Fax. + 33 (0)4.42.85.99.55

Marignane, 5th June 2003

revious ones addressing the kevlar tail rotor blade issue, this letter is only issued in English version ll Customers.

r Customer,

s third Information Letter addressing the tail rotor kevlar blade issue aims to provide you n a progress update. We hope this will help you to anticipate any decision for your fleet.

Fleet situation :

et availability impact has been much lower than expected, thanks to all your provided data t helped to build-up a blade per blade follow-up on nearly all affected aircraft. Less than of the concerned fleet is now being AOG and EUROCOPTER forecast shows that the uation should get better and better in the future.

Crack detection means :

s indicated in former Information Letter, EUROCOPTER experts have tried to perfect a ack ignition detection means. After analysis of all possibilities, as no industrial method was ossible to be developed in due time, EUROCOPTER has abandoned research process. levertheless, EUROCOPTER still requests that removed blades must not been destroyed and ave to be kept in quarantine, waiting for further instructions.

Blade design modification :

Modified blade with a replacement joint material has been DGAC approved on 21st May 2003. New P/N 365A12-0020.04 and 365A12-0020.05 respectively replace P/N 365A12-0020.02 and 365A12-0020.03. New blades S/N will start from 40 000 for easier identification.

EUROCOPTER, S.A.S au capital de 551 962 907,10 Euros, immatriculée au R.C.S. d'Aix-en-Provence sous le n° B 352 383 715
dont le Siège social est situé Aéroport International Marseille-Provence - 13725 Marignane Cedex - France

r lead time reasons, as EUROCOPTER focussed on the earliest replacement possibility, dified blades are delivered with a provisional life limit (SLL) of 160h also. Fatigue tests are ntinuing to be conducted with the aim to increase the SLL progressively.
lex Alert 00000130 is also issued today, validating the blade SLL and maintenance program.

Blades deliveries :

he blades production rate has reached its highest level as announced in former Information etter, with a doubled number of blades being monthly manufactured (about 450 per month).
eliveries planning is still established on a daily basis, in order to minimise and anticipate as uch as possible on any individual aircraft grounding period.
Only new P/N blades will be delivered from now, and will replace progressively former P/N ffected by the ASB with the aim of a 100% replacement. As previously announced, EUROCOPTER reminds that the first set of new blades is delivered to you free of charge on condition that the serial number of each replaced blade is provided.

Eurocopter remains mobilised for shortening this period of difficulties as much as possible and want to thank you once again for your comprehension and help. Our network remains focussing on this matter with for you the possibility to join any member for additional information or specific needs.

Next information is scheduled early July, focussed on new blade SLL extension progress status.

Yours faithfully,

Véronique CARDIN
Product Manager Dauphin/Panther Helicopters

Antoine FLEISCHMANN
Product Manager EC Technical Support

EUROCOPTER, S.A.S au capital de 881 962 907,10 Euros, Immatriculée au R.C.S. d'Aix-en-Provence sous le n° B 352 383 715
dont le Siège social est situé Aéroport International Marseille-Provence - 13725 Marignane Cedex - France

4.1 Micro-analysis of Deformed Leading Edge on Blades 4 and 5

Selection of Samples

To determine whether the blades had hit the iron mooring bollards, the part was examined for traces of iron. The microanalysis did not detect any iron on the titanium leading edges.

eurocopter an EADS Company INDUSTRIAL COMPETENCE CENTER QUALITY DEPARTMENT	MATERIALS LABORATORY REPORT O/IQL No. 3017/2003	Page 1/50 Date: 20/10/03 Author: N. MOURRE

TITLE

ACCIDENT TO 365 N2 NIGERIA (SCHREINER)

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OIQ→OIQL	CH	OTI	OTM	QA
OI		OTIS	OTMP	QAME
OID→OIDO		OTIN	OTMP/M	OIQP
OIP→OIPT		STSV	OTMC/M	

Group Head	Department Head "Materials Laboratory"	Quality Manager for the Industrial Competence Centers
Signed	Signed	Signed
O. GOUPILLON	M. PIERANTONI	JM. POULIER

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On the most damaged blade (No. 35317), all that is left on the TRH is the attachment insert with part of the Kevlar tie bar assembly (trailing edge strand).
The next blade No. 36853 (blade No. 11) was cut in half, and its tip section was missing.
The Fenestron duct was cut, with two holes at the 11 o'clock and 12 o'clock positions.
The TGB flared coupling was broken.
The TGB support tube was broken.

2- Blade No. 35317

The blade has fractured in two places:
- the tie bar assembly had failed at the bushing on the leading edge side.
- the tie bar built-in restraint in the blade had failed at the seal termination (station X158).

The fracture near the bushing was a **static failure**.
The fracture at the built-in restraint was a **fatigue failure**.
The tie bar fracture was partial through the thickness: 1.3 mm out of a total thickness of 3.5 mm was lost over 5 mm of the total 13.2 mm chord length.

The checks performed – the manufacturing file was examined and the tracer threads counted – indicated that blade No. 35317 was compliant with its definition.

3- Blade No. 36853

Blade No. 36853 was blade No. 11, the blade following after.
The blade had fractured at mid span, and the leading edge was deformed and scratched.
Chromium oxides were found in the microanalysis of the leading edge; they could correspond to the protective coating on the bearing of damaged blade No. 35317 (the bearing was not found).

4- Examination of the Other Blades on the Tail Rotor

Two other rotor blades were destructively examined in the root area at X158 where the following damage was found:
- a white mark on the lower surface of the trailing and leading edge strands of the tie bar assembly.
- a white mark was analyzed using the MEB method, which indicated damage to the resin with a few broken Kevlar fibers present.

5- TGB Tube

No non-conformities were found in the analysis of the manufacturing file, the part complied with its definition.
The tube fractured in two places:
- one fracture at the built-in restraint with the duct (break at bearing A)
- a second fracture at one of the attachments picking up the TGB (break at bearing B)

Both fractures were caused by static loading. The tube was bent by the fracture of the damaged blade n°35317. When it fractured, this blade generated an imbalance on the rotor that caused the hub to move, which in turn fractured the tube and flared coupling.

- MGB Fan and Guide Vane Assembly

ll the fan blades were broken.
visual examination of the guide vane assembly revealed that one of the fan blades had hit the guide vane ssembly.
ll the blades had the same fracture topography, i.e. **fast static failure**.

7- Summary

Based on the observations made, the rotor was probably damaged according to the following sequence:

- failure of blade No. 35317 after incipient fatigue at X = 158 mm, followed by the static failure of the other parts of the blade.

- static failure of blade No. 36853, followed by the failure of blade No. 33317 (blade No. 36853 followed after blade No. 33317)

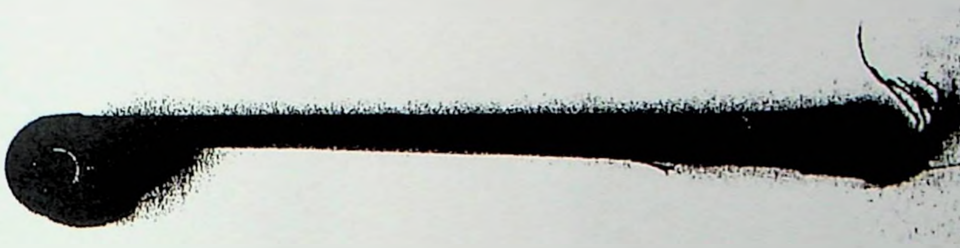
- other rotors components damaged and broken by the two preceding events. This scenario is confirmed by the numerous visible rub marks and impacts.

The examination of the other blades at X = 158 confirmed the presence of incipient damage in the form of white marks and causing local deterioration of the resin combined with damage to the fibers.
Although the reason for the incipient fatigue was not positively identified as several parameters (loading, temperature, aging, etc.) could have been involved.

EXAMINATION OF BLADE No. 35317

1 Visual Examination

Blade Root – Upper surface



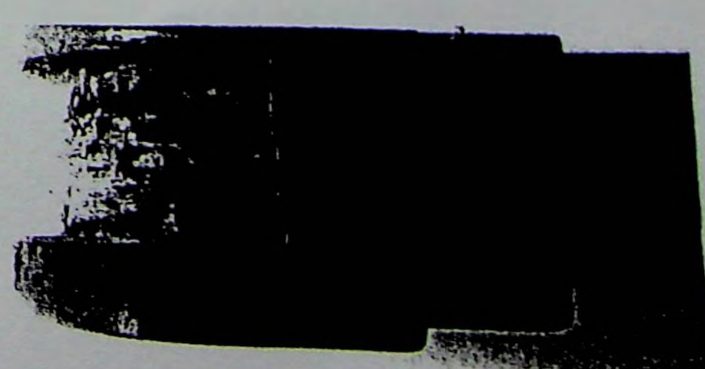
The spar strand on the leading edge side has disappeared.

Blade Root – Lower surface

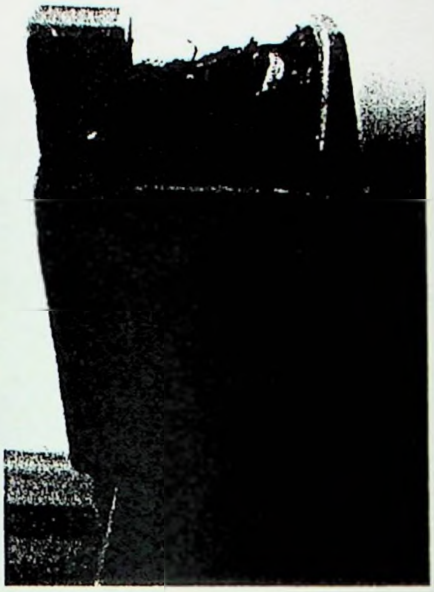
Blade Root – Upper surface

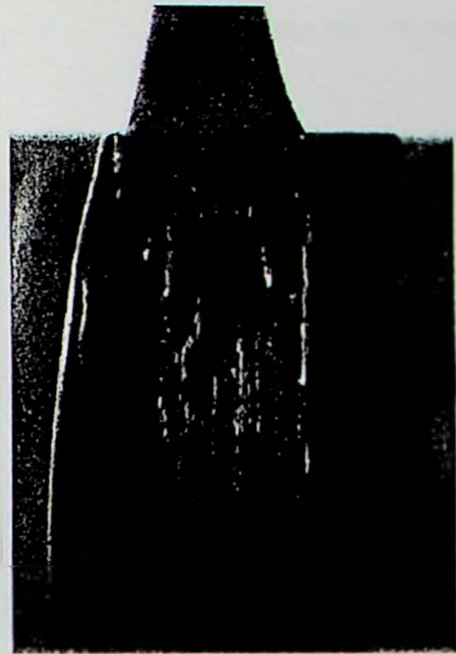
Blade Root – Lower surface

Bushing – Leading Edge Side

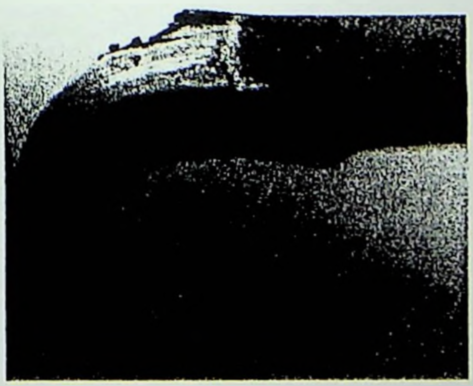


Bushing – Trailing Edge





3.2 Visual Examination after Removal of Bushing

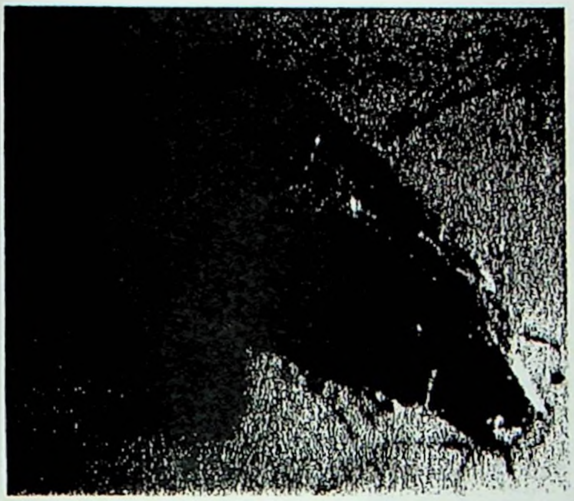


Bushing – Upper surface

Bushing – Lower surface

View on A

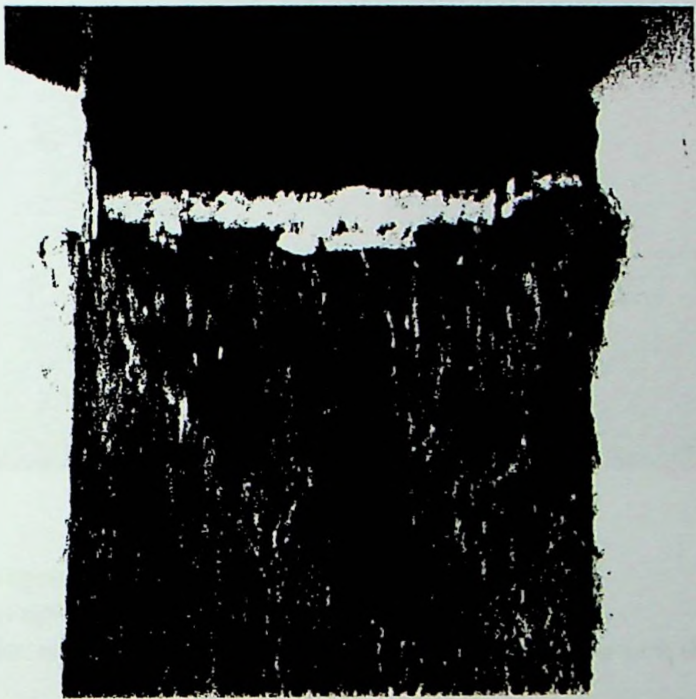
Slight depression on surface of the tie bar assembly (trailing edge side), and a break in the resin. The bushing ended up pressed against the spar.



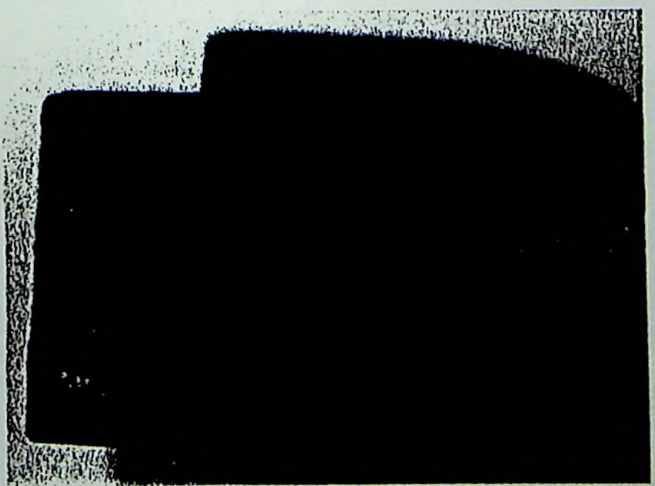
3.3 Visual Examination after Cleaning

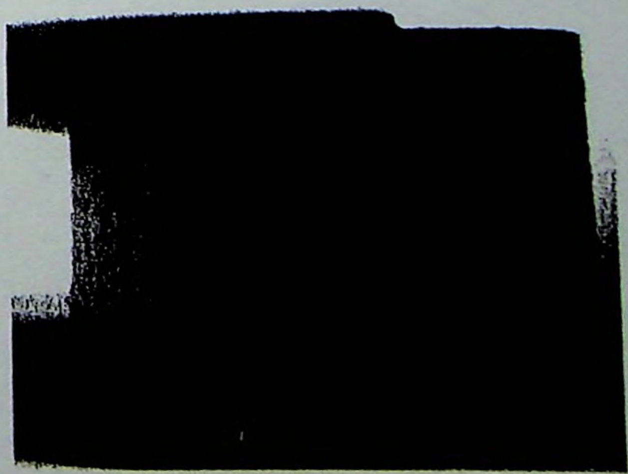
Failure at Bushing on Leading Edge Side

Failure at Trailing Edge



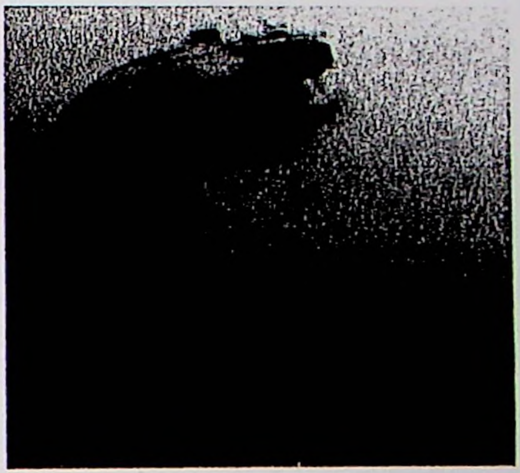
3.4 Examination of the Bushing





Measurements

.1 Failure of Tie Bar Assembly at Bushing

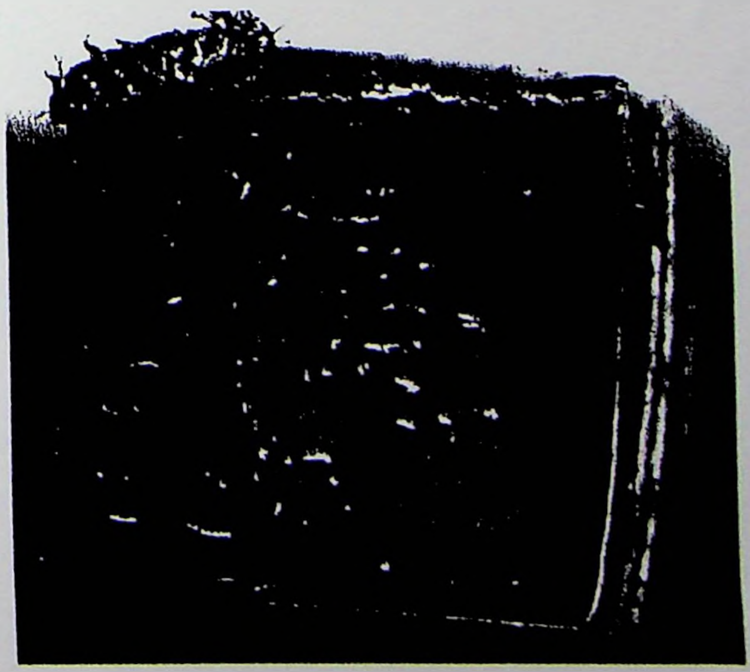


Dimension measured on a specimen tie bar assembly: 4.38 mm
Part of the tie bar has been delaminated.
A 1.02 mm length of Kevlar is missing on the Upper surface, and 1.40 mm on the lower surface.

3.5.2 Failure at Tie Bar Assembly Built-in Restraint with Blade, at Seal Termination (station X = 158)

3.6 Check of the Number of Strips forming the Tie Bar Assembly

The glass tracer threads were counted in a macrographic (cross-section) examination:



Twenty-four (24) tracer threads were counted.
The tie bar assembly should have 24 Kevlar strips, and **it is therefore in conformity**.

3.7.2 Analysis of Failure at the Tie Bar Assembly Built-in Restraint in the Blade (station X158)

Excerpt from Report

3178/90

aerospatiale

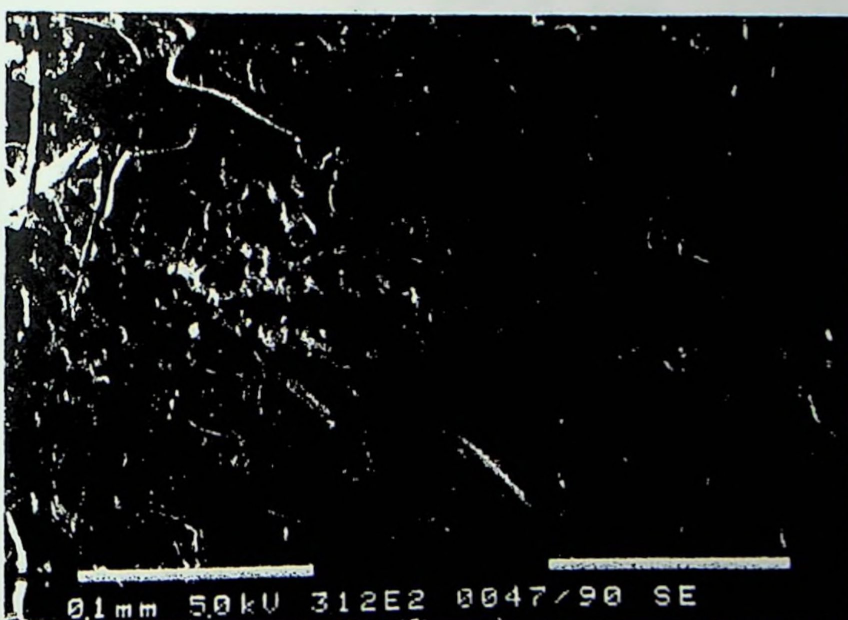
Etablissement de MARIGNANE

DIRECTION QUALITE

LABORATOIRE MATERIAUX

FATIGUE SUR ROVING KEVLAR (11254)

FACIES FIBREUX



THE ADDENDUM

BEA's final comments
And
Disagreement with the
AIPB.

BEA FINAL REPORT COMMENT

(Some comments to explain BEA and other investigations team position:

The CVR stoppage is not the beginning of the accident It is an incident without any effect with the accident, which is the loss of control of the helicopter on short final.)

. Section. 2.2: Remove all the section and write as following:

"The aircraft was supposed to fly at its cruising altitude of 700 feet above sea level as this was broadcast to the Area Network Controller and at its cruising speed (the normal cruising speed is 135 knots) when the float bags suddenly inflated. The investigating team considers possible scenarios for the floats to deploy.

(Some comments to explain BEA and other investigations team position:

- we are not completely sure that the helicopter was exactly at 700 ft and 135 knots.

- "Intentional command or an involuntary command" is different to Circuit activated by an outside factor or a technical deficiency and Float inflation by the crew).

2.2.1 Circuit activated by an outside factor or a technical deficiency

Considering the fact that, if there was no command input from the crew for the float to deploy, the remote possibility remains that, the circuit could be triggered by an outside factor or by a technical deficiency. However, it is not possible that using a mobile phone could succeed to activate the electrical circuit of the float gear.

In addition, nothing, particularly in the electrical circuit, has been found which could explain such activation.

Nevertheless, the investigating team believes that this event of the float deployment has no consequences on the capability of the helicopter to fly and to perform a landing at the helipad. The only effect is, perhaps, it could have placed a little stress situation on the crew after the surprise caused by the sudden inflation. But the team believes, this stress has no relationship with the other following events.

2.2.2 Float inflation by the crew

It seems that, it only could be a pilot error and not a voluntary action. Indeed, it is possible for the crew to push, inadvertently, the float inflation switch on the collective lever, which is not really protected from an accidental action from the crew.
In addition, as a matter of fact, there was no reason for the crew to activate the float at that moment of flight mode. Indeed, not type-rated pilot would, knowingly, deploy the floatation gear at this speed, because, firstly, the flight was over the ground and not over the water and, secondly, the flight was supposed to be in the cruising phase at the cruising speed of about 135 knots. Then, according to the Aircraft Flight Manual (AFM), the never exceed speed for inflating the floats is 90 knots.
It is to be noted that the crew should have altered the position of the float control switch on the instrument panel to the "ARM" position in order to be able to activate the floats. Indeed, the switch was found in the "OFF" position after the accident."

. Section 2.3: Remove all the section and write as following:

"2.3 The CVR Stoppage

It is to be noted that no indication of the gear inflation noise was registered by the CVR, which means that the CVR had stopped before or at the beginning of the inflation. According to the testimonies it is believed that the CVR stopped functioning simultaneously with the deployment of the float bags but the investigating team considers all possible scenarios for the CVR stoppage.

2.3.1 Technical deficiency

All the tests performed on the CVR and its electrical circuit after the accident did not reveal any technical deficiency that could be attributed to the electrical or mechanical system of the cockpit voice tape recorder. During the examination, the mechanical sub assembly and the micro switch of the recorder were correctly operating.

2.3.2 High acceleration which activated the G-switch

It should be noted that, the CVR is designed to mechanically stop functioning at a high acceleration of 6G, which is practically unattainable in the conditions of float inflation at, even above the exceeded maximum authorized speed of 90 knots. It is also believed that it is quite impossible for a helicopter to attain acceleration during flight that will produce the force of 6-G.

2.3.3 Particular vibrations which activated the G-switch

Particular vibrations which can be associated to a frequency of 1300Hz and which could be created by the combination of the vibrations generated by the gas pressure of the float bottles attached to the helicopter's structure to where the G-switch was attached and the vibration status of this structure at 135 knots, could have activated the switch, which disengaged and opened the electrical system to the tape recording head.
(Some comments to explain BEA and other investigators team position: in above text there are small modifications and the different hypotheses appear more clearly)

. Section 2.4 The engines performance: OK

. Section 2.5 Throttles position: correction of text
"the gate was not correctly closed" should be written as "the gate was probably not correctly closed"

. Section 2.6 Loss of control of the helicopter:
-Paragraph (iii): remove "the loss of effectiveness of the tail rotor blade" and write" the loss of effectiveness of the tail rotor" in line 8.

. Section 2.7 Scenario of the accident
-First paragraph: remove "might have"

Third paragraph:
remove "For several ensuing minutes" and write "After several moments"

- remove "the crew was in total control of the helicopter" and write "the crew regained control of the helicopter"
- From fourth paragraph until tenth paragraph: all text cannot be agreed and is not in accordance with what was agreed during out last meeting. In addition, many arguments are not correct or based on assumptions.
  Some comments to explain BEA and other investigations team position:

Fourth paragraph

- We can't agree with "the crew were not in total control of ANY situation". Indeed, the helicopter has been stabilized and according to all testimonies, it was flying normally until the loss of the tail rotor efficiency.

- It was not the "the main reason why the helicopter should have been, immediately, put down at any appropriately chosen area". In fact, are there some appropriate areas? A river is not an appropriate area and has to be used only in emergency conditions like a tail rotor failure, both engine failure,... etc. In addition, to realize an approach and a landing on a river is not so easy with the proximity of trees. And, the heavier the helicopter is the higher the stress on the tail rotor blades will be and therefore of more importance. So, the tail rotor failure could have happened with grater probability if the crew had performed a landing in the river. Finally, in case of an uncontrolled landing it is more likely that everybody would have been killed.
- We can't agree with "the aerodynamic and controllability of the helicopter would become unpredictable to the crew. "The crew flew normally until the loss of the tail rotor efficiency. In addition, Eurocopter test flights during certificate showed that normal flight is possible with floats inflated with les than 90 knots.
- We can't agree with "It looked like the commander did not consider the imposed danger that could occur to the lives on board and that he should act on the side of caution rather than hoping that the aircraft must get on to the helipad. "Firstly it is an assumption that is not proven. Secondly, normal flight was well possible with floats inflated and returning to a landing sport was more acceptable and safer than ditching in the river. A landing in a river, even with floats inflated, constitutes a special situation. Thirdly, the commander probably thought to perform an emergency landing in the river but he decided to land on the helipad, which can be seen as a safe decision.

Fifth paragraph:

- We can't agree with "the commander still continued to press on, irrespective of the consequences of operating the helicopter in an unpredictable aerodynamic environment with the floats deployed, especially when the aircraft manufacturer has no specific and clear-cut instructions concerning continuous flight operation with the floats fully deployed." Indeed, flying with the floats is not a normal flight condition since it is an equipment scheduled for an emergency landing in the water however it is not dangerous if you don't exceed 90 knots. What we also know by the testimonies is that the helicopter returned back to the helipad without any uncontrolled movements.

- We can't agreed with "This is like flying against unknown odds, as any aviator would rightly know that disturbed aerodynamic flow over and around an airfoil is critical to the sustenance of any aircraft in flight." In fact, it's right to say that the aerodynamic flow of the air around the helicopter was disturbed. However, it was not critical to the sustenance because, once again, an helicopter can fly with the floats inflated (under 90 knots) and we know, according to the testimonies, that the helicopter flew back safely until the short final.

Sixth paragraph:

- we can't agree with "The float occurrence would have been cited as an incident, if the aircraft had been ditched immediately in accordance with over water emergency operation. "In fact, the helicopter could have crashed into the river not because of a mishandling (in that situation, a landing with a helicopter, which was capable to fly normally, was not a difficult exercise. But, because of the heavy load (the helicopter got some more fuel than when he was near the helipad. It is true that the difference was not important but when you fly with a heavy load, a small supplementary load can be critical, particularly, in short final and landing where the stresses on both rotors are the most important.
- We can't agree with "The decision of not landing or ditching the aircraft immediately is the beginning of the accident." Indeed, we could say that not have put the float control switch on the instrument panel to the "OFF" position is the beginning of the accident. We could also say that the poor cockpit recourse management (CRM) of the crew, registered on the CVR, is the beginning of the accident .

  In fact, 5N-BBS accident is the crash of the helicopter into the container. The purpose of an investigation is to determine the causes of an accident. Only the tail rotor failure is contributive to the crash into the container. The other events (CVR stoppage, float inflation, float control switch to the "OFF" position, poor CRM, approach with a tail wind, poor condition of the fabric covers, the container and the non-compliant lacing,... etc) don't constitute contributive causes to the tail rotor failure (crash of the helicopter) but could be contributive to an accident in other conditions. For instance, when two helicopters are in close position at a cruising speed in a military exercise, one of them inflates the float and becomes uncontrollable during some seconds involving the collision with the other helicopters. In that case, the float inflation is the cause of the accident.

. Seventh paragraph:

- Remove "with the partially disabled helicopter" and write "with the float inflated"
- Remove "advocacy" and write "argument"
- Add that "When ditching the helicopter, the failure of the tail rotor blade could have happened at that time. And the consequences could have been more serious."

. Eighth paragraph: We can't agree with the text.

- it's not sure that "co-pilot, if he were to be in command, would have settled the helicopter on the river." Indeed, the Co-pilot appears firstly completely shocked by the uncontrolled movements created by the float inflation. For him (he normally has the controls) and as there is not a good CRM in this crew, it is possible that he certainly thought that in front of the uncontrolled movements the commander has decided to inflate the float and to ditch in the river. Very anxious and certain because of the poor communication from the commander, her has broadcast "ESO, please look for us on the river."

  After becoming calm, calm, as he appeared to the passengers and after the helicopter was controlled, it is not sure that if he was in command, he could have thought that to ditch would be the most appropriate and logical precautionary procedure to perform."

  We can't agree with "the unknown aerodynamic consequences" and "(since there was no guidance provided by the aircraft manufacturer)". Indeed, the aerodynamic consequences of inflated floats are not unknown, they have been proven by test flights by Eurocopter during certification. The control of the helicopter is secured under 90 knots. There is no guidance because the float is emergency equipment and not an usual equipment. In the contrary, it is not sure, according to the personality and the flight capacity of the Co-pilot that he would have performed a correct ditching in the river in such shocked and stress conditions if he was in command of the helicopter.

. **Ninth paragraph:**

- Remove "The helicopter then became uncontrollable until it impacted with the container on the barge, which caused the accident." Because text suggests that the container caused the accident, while the failed tail rotor caused the helicopter to collide with the container. So write "The helicopter then became uncontrollable and impacted the container on the barge."

. **Tenth paragraph:**

- Remove "It is clearly on the flight path" and write "it is clearly the last section of the flight path."

. Section 2.8 The AIPB's Final Comment: with
. Some comments to explain BEA and other investigators team position:

. **First paragraph:**
All AIPB's comments have already been commented in previous paragraph and we don't agree to AIPB's comments in this first paragraph. In the contrary, we agree in the fact that "leadership involves teamwork and good quality of leader depends on the success of leader's relationship with the team." It is clear that in that event, according to the CVR, CRM was not good. These belong to "Human Factor" but this has no relation with the deficiency of the tail rotor blade, which is a technical deficiency and constitutes the cause of the accident.

. **Second, third and fourth paragraphs:**
- **It is a fact. But, are such details necessary?**
- **Did we carry out all investigations concerning the past of the two pilots?**
- **To be rigorous, should we not have to write a paragraph about the personality and the past of each pilot?**

In conclusion for these three paragraphs, we think that relationship and CRM were not good but have no influence in the accident that, once again, due to the rupture of the tail rotor blade.

But such relationship and CRM could involve to an accident in other conditions.

. Fifth paragraph:

AIPB's argument is based on the fact that, during ditching on the river or waterside bank, the failure of the tail rotor blade could not happen. Perhaps! But, we don't know. What we are sure is that the conditions for a ditching on the river or waterside bank were very similar and perhaps worse. So, the stresses on the tail rotor blade were very similar and the consequences would normally have to be similar.

. Sixth paragraph:

AIPB's argument is based on "one-man decisions" "often resulted in serious incidents and accidents." It's true but in this event it's not the cause of the accident Also, we cannot prove it's a one-man decision", we don't know.
We agree that "Cockpit Resources Management (CRM) topics should always be a part requirement in the Nigerian Pilot recurrent training program for all operators" because in this event we noticed the poor CRM on the CVR recording.

. Chapter 3

- Paragraph 3.1.1: remove "cycles" and write "landings"
- Paragraph 3.1.8 remove "the possibility exists that"
- Paragraph 3.1.10: remove "the commander took over ... from the copilot" and write "The crew had"
- Paragraph 3.1.14: add "about" just before 1300Hz
- Paragraph 3.2.0: remove "probable"
- Paragraph 3.2.1: remove "probable

  Remove "the tail rotor control on the final approach" and write "the tail rotor on the final approach"

Paragraph 3.2.2: to remove: it is not a cause of the accident but an event without any effect on the tail rotor failure.

But such relationship and CRM could involve to an accident in other conditions.

. **Fifth paragraph:**

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the floatation bag inflation nor the subsequent flying of the helicopter with the bags inflated

Paragraph 3.1.25 We suggest to write a paragraph in the conclusion: "The float inflation was inadvertently activated by the crew. The float activation supposedly also caused the CVR to stop functioning".

Paragraph 3.2.3 to remove: it is not a cause of the accident, because : "indeed, the decision to return to Brass was not unreasonable, and in our opinion was a better decision than to ditch. Having re-established control of the helicopter, it was not necessary to ditch on the river, there was no requirement either in the ACN's Operation Manual or indeed the Manufacturers Plight manual requiring a ditching in the event of float deployment. The only relevant comment was that the 'never exceed' speed for float inflation is 90 knots. There is no guidance on what to do in the event of a deployment above that speed and most certainly no instruction to ditch. In addition, if the crew performed a ditch, it would have been quite possible that the blades would have failed in the shout final over the river or over perhaps the trees as the stresses on tail rotor are the most important. The consequences would have been probably more severe.

There is no objective evidence as to how the crew dealt with matters and how the decision-making process unfolded. As the CVR had stopped recording it cannot be determined if it was the Commander who imposed his will.

The crew could not be certain whether all bags were properly inflated, as they were inflated above 90 knots, which could have very adverse consequences when landing on water.

3.1.25 We suggest to write a paragraph in the conclusion: 3.1.25 "There was a poor CRM in this crew"

Chapter 4 : No comments