NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

December 29, 2008

# AIRWORTHINESS GROUP CHAIRMAN'S FACTUAL REPORT

MIA08MA203

## A. ACCIDENT

| | |
|---|---|
| LOCATION: | District Heights, Maryland |
| DATE: | September 27, 2008 |
| TIME: | 2358 eastern daylight time (EDT) |
| AIRCRAFT: | Aerospatiale SA365N1, N92MD, Operated by Maryland State Police, Maryland |

## B. AIRWORTHINESS GROUP

| | |
|---|---|
| Group Chairman: | Ronald C. Price<br>National Transportation Safety Board<br>Washington, DC |
| Member: | Lindsay Cunningham<br>American Eurocopter<br>Grand Prairie, Texas |
| Member: | Richard Jones<br>Federal Aviation Administration<br>Baltimore FSDO, Maryland |
| Member: | Joan Gregoire<br>Turbomeca USA, Inc.<br>Grand Prairie, Texas |
| Member: | David Rosenberger<br>Maryland State Police<br>Martin State Airport<br>Essex, Maryland |

Member: John Stevens
Maryland State Police
Martin State Airport
Essex, Maryland

## C. SUMMARY

On September 27, 2008, at 2358, eastern daylight time, an Aerospatiale (Eurocopter) AS365N1, N92MD, call sign Trooper 2 (T2), registered to and operated by the Maryland State Police, as a Public Use medical evacuation flight, was substantially damaged when it collided with trees and terrain in Walker Mill Regional Park, District Heights, Maryland. The flight had been cleared by air traffic control for an instrument landing system (ILS) approach to runway 19R at Andrews A.F. B. (ADW), Camp Springs, Maryland. Instrument meteorological conditions prevailed at the time of the accident. The commercial pilot, one flight paramedic, one field provider, and one of two automobile accident patients being transported were killed. The other patient being transported survived the helicopter accident and was taken to a local hospital with serious injuries. The flight originated from a landing zone located at Wade Elementary School, Waldorf, Maryland, on September 27, 2008, at 2337, destined for the Prince George's County Hospital (PG), Cheverly, Maryland.

The Airworthiness Group was formed to record and document the information regarding the helicopter wreckage and maintenance records. The group began its investigation on September 28, 2008, at the accident site in the Walker Mill Regional Park and concluded the on-scene portion of the investigation on October 2, 2008. The group reconvened on October 16, 2008, in Charlottesville, Virginia, to examine the engine parameter recorder; on November 3-4, 2008, in Grand Prairie, Texas, to examine the two Turbomeca Arriel 1 engines: and on November 10-13, 2008, in Melbourne, Florida, to examine the Rockwell Collins Navigation, Radar Altimeter, and DME systems.

## D. DETAILS OF THE INVESTIGATION

### 1.0 WRECKAGE DISTRIBUTION

The wreckage was located 3.46 miles north of the approach end of Runway 19R (ADW) in a heavily wooded area located in Walker Mill Regional Park, District Heights, Maryland. The final wreckage position was measured to be approximately 38 degrees, 52.161 minutes north latitude, and 076 degrees, 52.363 minutes west longitude, and 267 feet mean sea level (MSL) altitude, as measured with a global positioning system (GPS) indicator. All recovered portions of the helicopter were found in the wreckage debris field (including debris recovered from the trees). Examination of the helicopter's wreckage debris revealed no evidence of an in-flight or post-crash fire. Examination of the crash site revealed the helicopter initially collided with the upper section of an 80-foot tall tree in a wings level, descending attitude on a

heading of 191-degrees magnetic. Main rotor blade debris and a piece of the horizontal stabilizer end plate were located adjacent to the initial point of impact (IPI). A curved 14-inch piece of the main rotor blade leading edge was located 12 feet to the right of the crash debris line (CDL), and a piece of a horizontal stabilizer end plate was located 25 feet to the right of the CDL. The helicopter continued forward approximately 57 feet and impacted a 78-foot tall tree. A mid to outboard section of the right horizontal stabilizer with end plate was found at the base of this tree. A three-foot section of main rotor blade leading edge material was found approximately 40 feet to the left of the CDL, and an 8-foot, 11-inch outboard section of a main rotor blade was found about 134 feet left of the CDL. The helicopter continued forward and collided with the top of a 70-foot tree. A 2-foot 10-inch piece of the main rotor blade was located 18 feet left of the CDL, and a 2 foot 6-inch piece of the upper fenestron was located 15 feet left of the CDL. The upper fenestron cap was located 8 feet to the right of the CDL and 114 feet down the CDL. The right side transmission cowling with intake still attached was located 124 feet down the CDL and 31 feet to the right of the CDL. The helicopter continued forward and collided with a 60-foot tree at about 36 feet and then again with a tree at approximately 33.4 feet where broomstrawed composite main rotor blade material was observed. The main section of the fenestron with a portion of left horizontal stabilizer separated from the airframe and was located just forward and to the left of this tree. Just forward of this assembly on the CDL was the tail rotor drive shaft cowling. The main wreckage came to rest on its left side, 163.8 feet down the CDL from the IPI, on a heading of 265-degrees magnetic. The debris field was located in an area that measured about 500 feet wide and 400 feet long. The damage was characterized by severe structural damage, separated components, broken main rotor blades, and fractured structural portions. There were numerous tree branches intertwined throughout the wreckage debris. The tree branches were fresh hardwood branches ranging from 1 inch to 10 inches in diameter with green leaves attached. There was a 10-inch wide, 5-inch deep concave depression in the nose of the helicopter that was consistent with a 10-inch tree trunk found on the fuselage of the helicopter. The helicopter was separated into three main parts and many smaller pieces. All four main rotor blade roots remained attached to the hub and each had impact marks with tree bark embedded in the blade fractures. Each main rotor blade was fractured approximately 8 feet outboard of the hub. The drive systems were fractured and the control system push-pull tubes were fractured in the same areas as the airframe structural breaks. The Maryland State Police documented the location of the wreckage and provided the wreckage distribution plot (**Attachment 1**).

## 2.0 AIRCRAFT DESCRIPTION AND HISTORY

The Aerospatiale SA365N-1 helicopter is a twin engine, single main rotor helicopter that has a retractable tricycle landing gear. There is a four blade main rotor system for lift and thrust and a fenestron (tail rotor) for directional control and anti-torque. The helicopter has four large doors, two located on either side of the helicopter, to provide entrance and exit for pilot and passengers. The four-bladed main rotor is mounted on the main gearbox, which is directly above the cabin. Two Turbomeca Arriel 1C1 engines are mounted side by side aft of the main gearbox. Both engines have

separate drive shafts to the main transmission, which reduces engine rpm and distributes torque upward to drive the main rotor, and aft through the tail rotor gearbox to drive the fenestron (multi-bladed ducted fan). The helicopter was equipped with two front seats with dual controls and an aftermarket medical interior including 2 rear seats and 2 litters, which could be removed and replaced with two seats.

The helicopter records show that the Aerospatiale Aerospace Company manufactured the helicopter as an SA365N1 "Dauphin", S/N 6311, on July 9, 1988. The type certificate and product support were absorbed by Eurocopter in 1992 when Aerospatiale merged with Messerschmitt-Bölkow-Blohm (MBB). The aircraft records indicated that N92MD, serial number (SN) 6311, was manufactured in 1988, by Aerospatiale and was issued an Export Airworthiness Certificate to the Maryland State Police (MSP). The aircraft records indicated that it had been issued a United States Airworthiness Certificate in 1989. At the time of the accident, MSP reported that the helicopter had flown 8,869.1 total flight hours and had 34,575 total landings.

## 3.0 AIRCRAFT INFORMATION

A review of the aircraft records revealed that the aircraft had accumulated 8,868.2 total flight hours as of the morning of the accident. The accident flight was approximately 0.9, which would have resulted in an aircraft total time (ACTT) of 8,869.1 at the time of the accident. According to the aircraft logbook, a 100-hour airframe and engine inspection was accomplished 3.2 flight hours prior to the accident flight on September 22, 2008, at an ACTT of 8,865.9. The aircraft logbook also showed that the Pitot/Static and Transponder inspections were accomplished on April 4, 2008, at an aircraft total time of 8,596.0.

The No. 1 engine, had accumulated a calculated 7,077.3 hours at the time of the accident, and the No. 2 engine had accumulated a calculated 7,426. 5 hours at the time of the accident. The No.1 engine was overhauled by Turbomeca USA on June 27, 2005. The total time at the time of the overhaul was 5,955 hours. The engine had accumulated 1,120 hours since the overhaul. The No.2 engine was overhauled by Turbomeca Canada, on October 30, 2006. The total time at the time of overhaul was 6,876.7 hours. The engine had accumulated 574.7 hours since overhaul.

The helicopter was last refueled at Andrews AFB (ADW) on September 26, 2008, with 60 gallons of JP8 fuel. The helicopter departed ADW with 1,180 pounds of fuel. The Hobbs meter when the helicopter departed ADW was 8,209.7 and the helicopter had been flown for 48 minutes plus start-up time at the time of the accident. The hobbs meter indicated 8,210.0 at the accident site. See **Attachment 2** for more information.

## 3.1 WEIGHT AND BALANCE

There was an estimated 78.5 gallons (526 pounds) onboard the aircraft at the time of the accident. An aircraft weight and balance form was completed prior to departure for the mission. The "scenario 2" section reflected the weight and balance based on the aircraft empty weight plus fuel onboard, weight of baggage, equipment, crew, and estimated 200 pounds per patient allowance. Based on the closest fuel option of 600 pounds on the form chart utilized by the pilot, the aircraft was within weight and balance limitations with a useful load of 720 pounds, N1 hover out of ground effect (HOGE) torque of 88%, and N1 hover in ground effect (HIGE) Torque of 77%. This estimation is conservative, the estimated fuel onboard was less than 600 pounds and each patient weight was likely less than 200 pounds. For more information see **Attachment 3**.

## 3.2 Cockpit/Fuselage:

The fuselage came to rest on its left side. The right side of the fuselage was crushed and exhibited horizontal scrape marks and the cabin was extensively damaged. The right side pilot's door was located in a tree near the main wreckage (Photos 1 and 2).

**Photo 1: Fuselage**

**Photo 2: Bottom of Fuselage with landing gear and night sun**

The following switch, gauge, and control positions were documented and are in Tables 1 and 2:

| Table 1: Instrument Condition | | |
|---|---|---|
| | **No. 1 or Co-pilot** | **No. 2 or Pilot** |
| Airspeed Indicator | 30 | 60 |
| Radar Altimeter | 45 ft. | 40 ft. with bug slap mark at 300 ft. |
| Horizontal Situation Indicator | Course 190, Hdg 190 | Off Glide Slope, CDI centered 190 |

| | | |
|---|---|---|
| Directional Gyro | Unk. | 191 degrees |
| Altimeter | Unk. | 0 |
| Vertical Speed Indicator | Plus 500 | 0 |
| Radio Magnetic Indicator | Pointer at 280, Hdg 010 | N/A |
| Engine T4 | 0 | 0 |
| Engine Oil Temperature | 0 | 0 |
| Engine Oil Pressure | 0 | 0 |
| Fuel Pressure | 0 | 0 |
| Hydraulic Pressure | 0 | 0 |
| Nav Selector | 2 | 2 |
| Attitude | Descending right turn | Tumbled nose down |
| Antitorque pedals | Right pedal forward | Destroyed |
| Cyclic | Destroyed | Destroyed |
| Collective | Destroyed | Destroyed |
| Fuel Flow Control Lever | Full aft | Full aft |
| Fuel Cutoff Lever | Closed | Open |

| Table 2: Other Indicators | |
|---|---|
| Loadmeter | 0 |
| Main Gearbox Oil Pressure | 0 |
| Main Gearbox Oil Temperature | 0 |
| Torque | 0 |
| Hobbs | 8,210.2 |
| Accumulator | 9 bars |
| Rotor Brake | Off |

### 3.3 Main Transmission and Rotor System

All four main rotor blade roots remained attached to the hub and had impact damage that included broken spars, missing blade afterbody, flattened leading edge erosion strips, and trailing edge delamination. The main rotor blades had tree bark and wood splinters in each fracture. The main rotor damage was consistent with blade impact with hardwood trees and each blade was separated approximately 8 feet outboard from the center of the hub (Photo 3). Foam and composite main rotor debris and most of the main rotor blade tip weight pieces were located surrounding and along the CDL to the main wreckage. All four arms of the Starflex main rotor head were fractured, and all four blade sleeves were displaced.

**Photo 3: Main Rotor Blades**

The engine-to-main transmission shaft flex couplings exhibited rotational damage and flange ear boltholes were elongated (Photos 4 and 5). The main transmission was removed and rotated by hand at the No. 1 engine input flange, which resulted in rotation of the main rotor head, No. 2 engine input flange, and the tail rotor drive output flange. The main gearbox chip detectors and oil filter were checked for particles and/or debris; all were observed to be clean.

**Photo 4: Main Rotor Transmission**

**Photo 5: Main Rotor Hub**

## 3.4 Flight Controls

The flight controls were examined for continuity and integrity. The right side cockpit flight controls were extensively damaged by impact forces and were fragmented from the pilot station aft to the cabin area. The left side cyclic was found jammed in place with the surrounding structure crushed. The left side pedals were found jammed in a full right position. The collective levers were broken from their attach areas. Continuity of flight controls could not be determined due to extreme fragmenting of the push-pull tubes. Each push-pull tube fracture was examined and exhibited evidence of bending overload.

## 3.5 Tailboom

The tailboom-to-fuselage junction cracked open, displayed multiple sheared rivets, multiple rivet areas that exhibited sheet metal tears, but was not separated. Tailboom skin aft of the tailboom mid section had fragmented and separated at 45-degree angles (Photo 6). The fenestron assembly and horizontal stabilizers separated as well and were found ahead of the main wreckage on the CDL. The full tail rotor drive shaft, from the forward splines aft to the tail rotor gearbox input spline, remained intact and was still attached to the tailboom with displaced hanger bearings. The tail rotor driveshaft cowling separated and was intact in the wreckage debris. The cowling attach points were found fractured.

**Photo 6: Tailboom with fenestron drive shaft**

## 3.6 Tail Rotor Drive System and Fenestron:

The forward spline coupling of the tail rotor drive shaft had separated from the main transmission output and exhibited scoring/polishing at the forward end. The tail rotor drive shaft remained in one piece attached to the empennage/tailboom. The aft spline coupling detached from the tail rotor gearbox, which was located within the fenestron assembly just forward of the main wreckage. The fenestron could be rotated by hand. All fenestron blades were present, and most exhibited some chord wise scoring on scoring marks on the forward and impact damage and intrusion from the blades on the lower portion (Photo 7).

**Photo 7: Fenestron**

## 3.7 Fuel and Hydraulic Systems:

A strong fuel odor was noted at the accident site. Four of the five fuel tanks were ruptured during the crash sequence, and some fluid consistent with the color and smell of JP8 remained in the left center tank. Red fluid consistent with hydraulic fluid was found in the hydraulic reservoir at the site. The dual body main rotor hydraulic servos and tail rotor servo remained attached. The right side single hydraulic pump remained attached to the main transmission; the left side dual pump was separated and found near its mount. The electrical back-up hydraulic pump used to extend the landing gear in the event of a main system failure was not examined.

## 3.8 External Equipment

The tricycle retractable type landing gear were damaged and found extended at the wreckage site. All three actuating (extend-retract) cylinder piston rods were found in the extended position. The nose and right main gear were found intact. The left main gear was found next to the fuselage and was separated from its strut attach points. The fracture surfaces were consistent with overload failures. The aircraft was equipped with a "night sun" searchlight. It was found attached by its lower attachment structure, but was separated at the upper attachment structure. The extend-retract mechanism was found loose. The night sun could be swiveled freely. The aiming mechanism was still intact. The light case was dented on its right side, and the filament was shattered. There was tree bark on the lower side of the night sun housing consistent with the night sun being retracted (stowed) during the impact sequence. The lower anti-collision light was sheared in its entirety from the lower fuselage skin. The aircraft was equipped with a forward-looking infra-red (FLIR) system. The FLIR ball separated at its structure attachment under the nose of the aircraft and was found past the main wreckage on the CDL. There was no hoist installed on the aircraft at the time of the accident.

## 3.9 POWERPLANTS

Both engines were separated and found near their mounts. They were entwined in the wreckage of the fuselage. The No. 2 engine was lying on top of the No. 1 engine. Both engines were resting on their left-hand side (Photos 8 and 9).

Fuel was present in the fuel lines of both engines. Oil was present in the oil lines of both engines. The axial compressor wheel, power shaft, and power turbine of both engines were easily rotated by hand; however, unusual noises could be heard from both engines.

The exhaust pipes and exhaust extensions of both engines were deformed and crushed inward on the left-hand sides. There were no fractures along the exhaust extensions. The containment shields of both engines appeared intact. The bleed valves of both engines were in the open position. The leading edges of the axial compressor blades on the No. 1 engine exhibited minor foreign object damage. Both engines, as well as the tachometer box for each engine, were removed from the wreckage.

Engine crates were shipped from Turbomeca USA to Walker Mill Regional Park, and the engines were prepared for shipment. The remainder of the coupling tube was removed from the No. 2 engine, as well as the exhaust extension from each engine, to facilitate shipment. Each engine was mounted on a shipping stand and secured in a shipping crate.

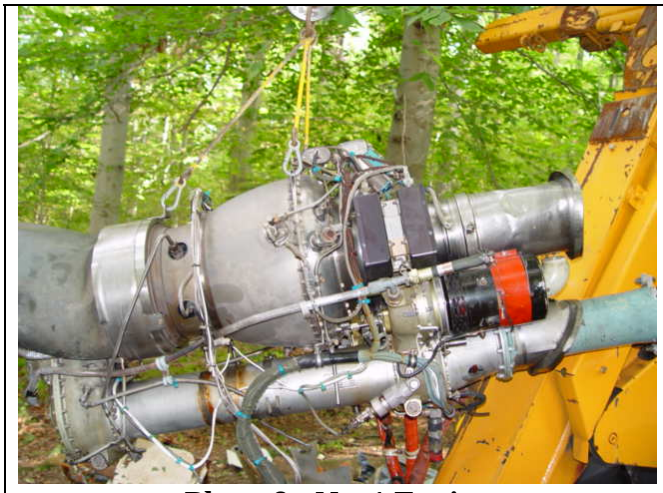

**Photo 8: No. 1 Engine**

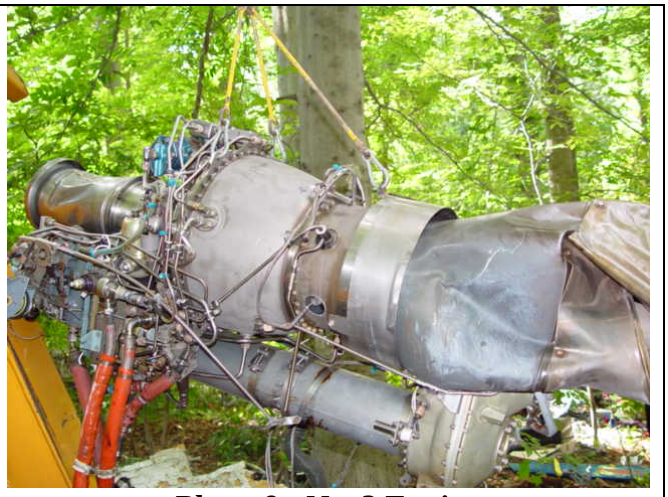

**Photo 9: No. 2 Engine**

### 3.7.1 Engine No. 1 (Left)

Turbomeca Arriel 1C1 SN 5102
Module MO1 Transmission shaft and accessory gearbox-SN 2472
Module MO2 Axial compressor-SN 2740
Module MO3 Gas Generator high pressure section-SN 5264

Module MO4 Power turbine-data plate inaccessible
Module MO5 Reduction Gearbox-SN 4381
FCU SN B099B

3.7.2 Engine No. 2 (Right)
Turbomeca Arriel 1C1 SN 5060
Module MO1 Transmission shaft and accessory gearbox-SN 2438
Module MO2 Axial compressor-SN 2599
Module MO3 Gas Generator high pressure section-SN 5168
Module MO4 Power turbine-data plate inaccessible
Module MO5 Reduction Gearbox-SN 4180
FCU SN A468B

## 4.0 MAINTENANCE RECORDS

The rotorcraft maintenance records revealed that the helicopter was being maintained in accordance with the manufacturer's recommended maintenance program that consisted of regularly scheduled inspections, parts replacements, and checks. This aircraft was being maintained in accordance with Eurocopter's recommended Maintenance Service Requirements, utilizing an AAIP (Approved Aircraft Inspection Program), which encompasses all inspections, overhaul intervals, and retirement items. The requirements for inspections, overhauls, retirement of components, Airworthiness Directives (AD), Service Bulletins (SB), and survival equipment requirements are tracked by a computer database. The AAIP inspections occur at intervals for standard inspections and are listed by component named for individual inspection/maintenance requirements. For details, see **Attachment 4.**

The last inspection that was performed on the helicopter was an AAIP 100 HR (25 hour interval) on September 22, 2008. The inspection was performed by a certified repairman under the authority of the MSP repair station, KY1R287K. The helicopter was approved for return to service and released for flight. The maintenance log indicated that there were several discrepancies and included a list of the malfunction in the Approved Minimum Equipment List (MEL) record and was authorized to continue flight. The helicopter was operationally checked and then cleared for flight.

## 5.0 TESTS AND RESEARCH

### 5.1 TELEDYNE AVIONICS PAR COMPUTER

On October 16, 2008, the Teledyne Avionic PAR[1] computer, model 7768, SN YL1003, was examined and the non-volatile memory was extracted at the manufacturer's facility in Charlottesville, Virginia. The exam revealed that the PAR computer unit was slightly damaged but the internal components were found intact. The memory was read,

[1] The PAR computer is a digital recorder that records both engine starts/stops. flight times, power checks, and engine parameter exceedances.

and the calibration of the unit was checked and found to be close to required specifications. According to the data, the PAR unit lost power on September 28, 2008, at a time of 00:04:58. The unit recorded no engine exceedances for the flight and recorded the data in Table 3 at the time of power loss.

| Table 3: PAR Recorded Data | | |
|---|---|---|
| ENG No. 1 | T4 | 465 C |
| | TRQ | 4.7 % |
| | NG | 77.4 % |
| | NP | 103.8% |
| ENG No. 2 | T4 | 501 C |
| | TRQ | 6.8 % |
| | NG | 78.4 % |
| | NP | 103.2 % |
| SHIP | TTQ | 11.5 % |
| | NR | 356 RPM |
| | PALT | 231 |
| | IAS | 92 KTS |
| | OAT | 19 C |

According to the data, the last power check was recorded on September 24, 2008, and was a check of the No. 1 engine. For more details see **Attachment 5.**

5.2 Turbomeca Arriel 1-1C1 Engines

The No. 1 engine, SN 5102 was examined at the manufacturer's USA facility in Grand Prairie, Texas, on November 3 through November 4, 2008. The engine had multiple dents in the intake and exhaust housings and the Fuel Control Unit (FCU) had external damage to the controlling mechanism. The engine was installed in a test cell with a factory supplied exhaust and intake. A factory supplied FCU was installed on the engine. The engine was leak checked, and test run in the cell. The engine was run to 100% N1 with no abnormal vibrations. The engine ran with normal fuel consumption, normal oil consumption, and did not exhibit any abnormal noises. There were several sparks that exited the exhaust and were attributed to wreckage debris passing through the engine. The engine was not cleaned before the test run. For details see Attachment 6.

The No. 2 engine, SN 5060, was examined at the manufacturer's facility in Grand Prairie, Texas, on November 3 through November 6, 2008. The engine had multiple dents in the intake and exhaust housings and the FCU had external damage to the controlling mechanism. The engine was installed in a test cell with a factory supplied exhaust and intake. A factory supplied FCU was installed on the engine. The engine was leak checked, and test run in the cell. The engine was run to 95% N1 with no abnormal vibrations. The engine ran with normal fuel consumption, normal oil consumption, and did not exhibit any abnormal noises. There were multiple sparks that exited the exhaust

and were attributed to wreckage debris passing through the engine, the engine was shut down due to the sparks and the turbines were examined. There were no apparent defects in the turbine assemblies that would indicate a deteriorated condition. The engine was not cleaned before the test run. For details see Attachment 7

The No. 1 FCU, SN B099B was examined at the manufacturer's facility and run on a test fixture. The engine control lever was removed due to damage and a factory-supplied lever was installed on the unit. The FCU performed adequately at all ranges of RPM and delivered close to the correct fuel flow. For more details, see Attachment 7.

The No. 2 FCU, SN A468B was examined at the manufacturer's facility and run on a test fixture. The engine control lever and inlet fuel elbow were removed due to damage and a factory supplied lever and elbow were installed on the unit. The FCU performed adequately at all ranges of RPM and delivered close to the correct fuel flow. For more details, see **Attachment 6**.

5.3 AVIONICS

5.3.1 Rockwell Collins DME Transceiver DME-42

The Rockwell Collins DME-42 Transceiver unit was examined at the manufacturer's facility in Melbourne, Florida, from November 11 through November 12, 2008. The unit showed that it was part number (PN) 622-6263-001, SN 5016, and had SB 1 through 4, 9, and 11 accomplished. The unit was tested on a test bench and revealed that at several frequencies (including the ADW VOR[2]) the unit performed correctly. The unit failed other bench checks, but would have met FAA requirements for operations. For more details, see **Attachment 7**.

5.3.2 Rockwell Collins Radar Altimeter ALT-55B

The Rockwell Collins ALT-55B Transceiver unit was examined at the manufacturer's facility in Melbourne, Florida, from November 11 through November 12, 2008. The unit showed that it was PN 622-2855-001, SN 11786, and had SB 1 through 5, and 7 accomplished. The unit could not be tested due to a damaged J2 connector. A factory-supplied connector was installed and the unit was tested on a test bench and the unit performed correctly. The unit failed other minor bench checks, but would have met FAA requirements for operations. For more details, see **Attachment 7**.

5.3.3 Rockwell Collins Navigation VIR-32

The Rockwell Collins VIR-32 Receiver unit was examined at the manufacturer's facility in Melbourne, Florida, from November 11 through November 12, 2008. The unit showed that it was PN 622-6137-001, SN 5647, and had SB 1 through 17 accomplished. The unit was tested on a test bench and the unit performed correctly. The unit failed other bench checks, but those tests are not relevant to operations in the helicopter

[2] Very High Frequency Omnirange Station

installation and would have met FAA requirements for operations. For more details, see **Attachment 7**.

5.3.4 Rockwell Collins Navigation VIR-32

The Rockwell Collins VIR-32 Receiver unit was examined at the manufacturer's facility in Melbourne, Florida, from November 11 through November 12, 2008. The unit showed that it was PN 622-6137-001, SN 5647, and had SB 1 through 17 accomplished. The unit was tested on a test bench and the unit performed correctly. The unit failed other bench checks, but those tests are not relevant to operations in the helicopter installation and would have met FAA requirements for operations. For more details, see **Attachment 7**.

5.3.5 Rockwell Collins CTL-32 Navigation Control Head

The Rockwell Collins CTL-32 Navigation Control Head unit was examined at the manufacturer's facility in Melbourne, Florida, from November 11 through November 12, 2008. The unit showed that it was PN 622-6521-016, SN 9578, and had SB 1 through 8, 10, 11, and 14 through 17 accomplished. The unit had extensive damage so the circuit board that contained the units non-volatile memory was extracted and placed in a manufacturer supplied control head unit. The unit was tested on a test bench and the unit performed correctly. The primary frequency that was in use at the time of power loss to the unit was 111.5 Mhz. For more details, see **Attachment 7.**

5.3.6 Rockwell Collins CTL-32 Navigation Control Head

The Rockwell Collins CTL-32 Navigation Control Head unit was examined at the manufacturer's facility in Melbourne, Florida, from November 11 through November 12, 2008. The unit showed that it was PN 622-6521-016, SN 9580, and had SB 1 through 8, 10, 11, and 14 through 17 accomplished. The unit had external damage that precluded direct bench testing. The unit was partially disassembled and was tested manually. The unit performed correctly. The primary frequency that was in use at the time of power loss to the unit was 110.5 Mhz. For more details, see **Attachment 7.**

5.4 Annunciator Panel

The annunciator panel light bulbs were examined in the NTSB materials lab. All bulbs were found intact and not fire damaged or with broken glass. Each bulb was examined for evidence of filament stretching, or other deformation of the filament. All 52 bulbs were found with no evidence of stretching or deformation.

Ronald C. Price
Aerospace Engineer

ATTACHMENTS

| | |
|---|---|
| Attachment 1 | Wreckage Diagram |
| Attachment 2 | N92MD Fuel Records |
| Attachment 3 | Weight and Balance |
| Attachment 4 | Maintenance Records |
| Attachment 5 | PAR Computer Download data |
| Attachment 6 | Turbomeca Engine Run Data |
| Attachment 7 | Avionics Test |